THE ENGINEERING MAGAZINE

79048

AN INDUSTRIAL REVIEW

VOLUME XV

April to September, 1898

NEW YORK

THE ENGINEERING MAGAZINE

1898

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THE

ENGINEERING MAGAZINE

VOL. XV. APRIL, 1898. No. 1.

THE SHIFTING SITE OF NATIONAL INDUSTRIAL SUPREMACY.

By J. Stephen Jeans.

WE cannot better determine the most likely course of the iron trade of the future than by seeking to ascertain and to apply the experience of the past. What, for more than half a century, has kept Great Britain in the front of this industry? What of late years has placed the United States in the position formerly occupied by Great Britain?

Industrial supremacy is largely a function of the character of the population. If the people of India or China were as competent, from an industrial point of view, as England or the United States, there could be no question as to the race with which ultimate supremacy would lie, assuming the possibility of maintaining the conditions otherwise the same. All production is more or less a function of labour, and as the nominal cost of labour in eastern countries is about one-twelfth the cost in the industrial centres of the United States, the race should be to the "Chinese cheap labour," if it were sufficiently effective. As it is, however, oriental labour has not come to the front for metal working to any extent worth speaking of, although it has made vast strides in textile industries, and we are consequently unable to compute the ultimate issues involved in its application to mining and metallurgy. Arguing from the known to the unknown, we can here add only that nominally dear labour is often the cheapest, and the paradox remains that the most highly-paid labour in the world on a large scale is able to turn out the cheapest work.

I delayed the completion of this summation of my recent articles in THE ENGINEERING MAGAZINE on "Supremacy in the Iron Market,"

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until I was in a position to estimate the consequences of the very serious strike that has for the last thirty weeks been raging in the engineering industry of the United Kingdom. If Great Britain has suffered more loss to her industrial prestige from one cause than another, that cause is the influence and action of the trade unions, whose guiding principle has been to turn out the smallest possible amount of work at the highest possible cost, and which are always seeking for concessions that are seldom sought or expected by the workmen of other countries. It is generally believed that the settlement of the engineering strike, announced January 28, will tend to put a check on the powers and demands of trade unions throughout the iron and engineering industries generally. If so, then I do not hesitate to say that a much brighter day for British manufacturing prospects will have dawned. No one who knows British labour as I do is likely to question its capacity, its skill, its doggedness, its power for producing really good work. The British workman has succeeded in making a high reputation for British manufactures in all parts of the world. I say nothing of the character of the industry of American workmen, but no Englishman need be afraid to compare his country's manufactures with those of any country in continental Europe, even if it is admitted that we are too prone to speak of German-made goods as "cheap and nasty."

The first element of success and supremacy in this as in most other important industries is the actual existence of a great demand for the manufactured products at home. It was undoubtedly this demand, more than any other single cause, which secured so large a command of the world's markets for the United Kingdom. It has been the home demand, also, more than any other single cause, or perhaps any combination of causes, that has built up the wonderful iron industry of the United States. The immediate effect of a large home demand is to bring many industrial establishments into existence, which compete with each other and with outside producers, in order that the cost of production may be brought low enough to leave a large competitive profit.

On the other hand, the absence of this large home demand has generally tended to keep the non-progressive countries to which it applies in a backward metallurgical condition, making the cost of manufactures expensive, and restricting the consumption by reason of the high prices of commodities. Take, as an example, the case of Russia. Although the population of that vast empire in 1880 was about a hundred millions, the actual production of pig iron in that year was not more than 465,000 tons, of finished iron 292,000 tons, and of steel 307,000 tons, whereas, in the same year, the United States, then a comparatively undeveloped country, produced nearly

four million tons of pig iron, and almost three million tons of finished, or semi-finished, products. The one country—it matters little how or why—was bent on a large and rapid development of its resources; the other was passive and inert, merely perhaps because its time had not yet come. The natural consequences have been that the United States have done a great deal to improve the conditions of manufacture, whereas Russia has done but little, and that the one nation to-day enjoys an abundance of cheap iron and steel, whereas the other has to pay higher prices than any other civilized country over a very wide area, and imports larger quanties from other countries than does any other nation with relatively equal, or approximately equal, population, resources, and requirements.*

America, then, has obtained the lead in the world's iron trade, in consequence of her own extraordinary requirements, compelling the highest attainable economy to be achieved and placed at the disposal of consumers. Has anything been done in this direction by the United States that other countries cannot rival? Is it probable that the United States are possessed of natural resources so exceptional, and consequently of the "unearned increment" of economical production, that they are not likely to be seriously threatened by the competition of other and newer countries in the not far distant future?

My own investigations lead me to the conclusion that no single country has thus been endowed by nature, and that the mineral wealth of the world is distributed over so wide an area that no single country can hope to enjoy supremacy, in so widely-diffused an industry as that of the manufacture of iron and steel, for a long period,—long, that is, as periods go in the history of the world. It may be that to-day the industrial situation of the United states, or of the United Kingdom, looks impregnable, but it is always much less so than it appears to be. It is not many years since I was confronted with figures which appeared to prove with convincing relevancy, that the cost of the production of iron in Nova Scotia would be less than on any other part of the American continent. I enjoy a fairly considerable acquaintance with the mineral resources of New South Wales, thanks largely to information communicated by my friend, Mr. Mitchell, of Sydney,—who, in his former position of member of parliament there, and since, has strongly advocated the establishment of a local iron industry,—and it would not surprise me to learn that, with the iron-ore resources of Carlo's Gap, Picton, and other parts of the colony, and the large coal-fields near at hand, iron could be manufactured in that distant

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*I ought to add perhaps that Russia is now making much more rapid progress. Her annual output of pig is 1,500,000 tons, and of steel about 700,000 tons.

colony as cheaply as in any part of the world. Then, again, every one is looking forward to the possibility of a considerable development, in the not distant future, of the mineral resources of British India, of China, of Siberia, and of Japan. So far as India is concerned, I have examined a number of the volumes of memoirs of the geological survey of that empire, and cannot fail to be struck with the evidence which they afford of vast mineral wealth, alike in coal and in iron ores, scattered with bountiful profusion over very wide areas. The demand for metals is not yet large enough in India to justify a large metallurgical industry, nor is it by any means certain that such a demand will speedily come about; but that, under suitable conditions, India could manufacture iron and steel cheaply scarcely admits of a doubt. Of China and Japan but little need be said, because, while both countries are at the present time engaged in building iron- and steel-works, no export trade from either is likely to be developed for many years.

Matters, however, are much more likely to ripen into a competitive trade in some European countries, and notably in Spain and Russia. I have received, within the last few days, a letter from my friend, Mr. Julio de Lazurtigui, of Bilbao,—one of the most intelligent of Spaniards, and one of the best authorities on the iron ore resources of Spain,—in which he speaks of a project for making pig iron in the Asturias from rich ores that can be delivered at the furnaces for about 5s. per ton, using coal which is mined near Gijon, thirty or forty miles away. Already, at Bilbao, a certain amount of trade has been done in the export of pig iron made on the spot from local ores and imported coke. As 50-per-cent. ores can be delivered at the furnaces for 5s. per ton, it follows that the total cost of the ores used per ton of pig is not more than 10s., and, although the cost of imported (English) coke is high, this difficulty is being to some extent met by introducing Spanish fuel, which is somewhat cheaper, and could be made cheaper still, if the demand were large enough. I had the pleasure of going over a number of the Spanish iron- and steel-works only eighteen months ago, and I confess to having been surprised at their mechanical and economic circumstances. If Spanish coke of good quality can be delivered at either Bilbao, Arles, or Rinaldes at 16s. per ton, I can conceive of no good reason why pig iron, both hematite and basic,—for both descriptions of ore are available,—should not be made for 28s. per ton, at which rate it would be the cheapest pig iron in Europe, except that produced, on a comparatively small scale, under very exceptional conditions, by the Peine Iron Company, near Hanover, in Germany.

So far as Russia is concerned, it seems almost absurd to speak of an empire that is now importing about three-quarters of a million tons of

iron and steel annually from other countries as likely to enter the ranks of iron-competing countries within a period of time worth taking account of. As a matter of fact, however, Russia may be much nearer to the attainment of this position than is commonly supposed. One can only guess at some of the geographical and economic results that are likely to follow upon the opening of the trans-Siberian railway. It is well known that Siberia is a country rich in minerals of every kind, and, although the present population is almost ridiculously small for such a country,—being less than six millions, or not more than 1.2 per square mile,—still, the advent of railway facilities must make a momentous change in the relations of orient and occident. Leaving this for the moment, however, I happen to be aware of a project now on the *tapis* for erecting large iron and steel works between the Caspian and the Black seas, which are intended to supply the requirements of a large part of Turkey and Persia, as well as of a certain area in Russian territory, now insufficiently provided for; and in one or two other centres aggressive ideas begin to be entertained.

Probably enough has been said to justify my argument that the future supremacy of any one country in the iron markets of the world cannot be guaranteed, because of the constant shifting of the conditions needed to guarantee such permanence.

Iron has been described as one of the most widely diffused of all the metals, and it is well that it is so, because no other metal is so much in demand. The present annual output of pig iron throughout the world is about 32,000,000 tons; in 1880, it was only about 18,000,000 tons; in 1870 only 12,000,000 tons; and in 1850 less than 5,000,000 tons. If the same rate of increase is maintained in the future, our annual consumption of pig iron in 1916 will be 46,000,000 tons, and in 1934—a date within the probable existence of most of the young engineers and metallurgists now living—it will be more than 60,000,000 tons.

If this enormous output should be called for, how and whence is it likely to be supplied? Is there any man conversant with the conditions of the world's iron manufacture bold enough to even hazard a conjecture, at the present time, as to where we might obtain an additional fifty million tons of iron ore annually, which would be called for by the iron consumption of thirty-six years hence, on the hypothesis just stated? This, be it remembered, would be an excess on present demands to the extent of almost as much again, and nearly three times the present actual consumption of the United States.

What countries are likely to make the largest contributions to this stock? Certainly Great Britain cannot do a great deal more than maintain her present output of nearly 15,000,000 tons annually. Ger-

many is in no better case, although she has Luxembourg and Lorraine to depend upon. France has not for many years succeeded in producing more than 3,500,000 tons annually, despite the large deposits of the Meurthe-et-Moselle,—a district which I have, within the last fortnight, had the pleasure of visiting. The future supremacy of the world's markets, all other things being equal, must, therefore, clearly lie with the country that can make the largest contribution towards this hypothetical quantity. Will that country be the United States? If so, to what extent can the United States furnish the difference? Are the supplies of the Lake Superior range practically inexhaustible? If not, how soon are they likely to be exhausted, if, as is probable, the drain upon them should be doubled during the next twenty years? And, if the Lake Superior ranges are near depletion, what other sources of supply can the republic muster? The solution of these several problems must involve large and probably totally unexpected changes within the next quarter of a century,—changes that call for all the discernment, foresight, and prevision at the command of those who are now engaged in the world's iron industry.

I hope that in what I have just written I may not be misunderstood. I quite realize the probability that the growth of the demand for iron may not in the future show the same progress—either arithmetical or geometrical—as in the past; and I need hardly add that all analogy and experience should prove that, whatever the increase of demand may be, it is certain to be supplied from some quarter. It may be that Pittsburg and Sheffield may some day be conquered in the Congo or in New Caledonia. But, however this may be, there is an element of uncertainty about the whole matter that should make us careful about obvious dogmatising in the face of so much obscurity.

Nor should we lose sight of the fact that a plentiful supply of minerals is not the one thing needful to industrial preëminence; otherwise the present *situs* of the iron industry would not be in Pittsburg and Chicago, Middlesboro and Sheffield, but in localities or countries that are as yet almost in the wilderness. Many other conditions are important, and even essential. A skilled and industrious population is especially necessary. Such a population is found in the United States, Great Britain, and one or two other civilized countries. It is rarely to be found in countries which, like Russia, are only semi-civilized, or in countries which, like Spain, have fallen back in the race for national preferment.

Now, if the unquestionable efficiency of the British workman, when on his mettle, is for the future to be allied—as it is hoped it may be—to a greater willingness to adopt what are called American methods,—in other words, to speed up machinery to its utmost, and

to run all capable plants for what they are worth,—it seems to me that the change will greatly modify the conditions that have prevailed in the past, and do prevail at present. It is to be assumed that in the best American works there is now little or no unexhausted reserve of force,—in other words, that the man and his work are employed to their utmost tension; but this is by no means the case in the majority of British works. On the contrary, it may be admitted that, to bring up these works to the highest efficiency known in American practice, there is probably an unexhausted margin of thirty to sixty per cent. to work upon. Will this margin be made use of? If so, to what extent? Our practice, as I have pointed out before, is steadily improving, alike in iron-making and in steel-manufacturing, but there is still much to be done. I am glad to be able to add that our leading works have narrowed the margin very much, even within the last year.

The Dowlais-Cardiff works in South Wales constitute a record establishment. The Barrow works have lately reorganized their bessemer plant, using 20-ton converters, and their labour costs per ton of ingots or rails will probably compare favourably with any in the United States. The great works of Bolckow, Vaughan & Co. have expended a large sum of money in supplying a larger amount of blowing power and in other improvements, so that they now command perhaps twice the volume of blast that they formerly had. Our open-hearth steel works, which are equal to an output of nearly three million tons of steel annually, are steadily improving their mechanical equipment, and can now produce steel plates for perhaps a third part of the labour cost of only a few years ago. The old country, depend upon it, has a great deal of "kick" left yet, and, among the many surprises which the iron trade of the future has in store, it is perfectly conceivable that one may be a resurrection of British supremacy on a scale that no one hardly dares to dream of at the present time, because John Bull is a pronounced pessimist, and rarely magnifies his industrial prowess or achievements, as is common in some other countries. I hope I am not an industrial Jingo; but, when one reflects that Great Britain has everything, excepting unlimited supplies of certain ores, within her own borders, and that she has the wide world over which to range in search of supplies,—which she must command on more favourable terms than any other country,—it is hardly likely that she is about to suffer much eclipse, *with fair competitive conditions*. Of course, the conditions that have recently prevailed have not been fair, and have given England but little chance. Her chief competitors—Germany and the United States—have more or less kept up prices at home, by pools, syndicates, or otherwise, and have dumped their surplus produce upon neutral markets, hitherto fairly occupied by Great

Britain, on terms that could not have been offered with profit, had they been depended on, as British terms always are, for dividends.

In one important condition affecting competition, apart from natural resources and efficient labour, there has been a wide difference in the past between the chief competing countries of the world, which is not likely to be perpetuated to the same extent in the future. I refer to the influence on cost of production exerted by the action of the State. The effect of legislation in the increased cost of producing coal has been very serious in Great Britain, authoritative estimates having placed it at 1s. 3d. to 1s. 6d. per ton. In Germany the effect of the introduction of the system of workmen's compensation for accidents has been to greatly increase the burdens on industry, the average of some large works being as much as 4 to 5 per cent. on the total amount of wages paid. One large concern that I have visited in Westphalia has paid as much as £25,500 in rates, taxes, and State obligations on a capital of only £800,000, and a *personel* of 11,313. In Great Britain the Workmen's Compensation Act of last year will come into operation on July 1, and will lead to similar results, although probably not to so serious an extent. Hitherto the United States have kept comparatively free from such burdens, as well as from the more serious burdens of conscription and the maintenance of a large standing army. Will this continue to be the case in the future? Will the United States continue to be as free from war burdens as hitherto, relatively to other countries? If the United States were "on an even keel" with European countries in these respects, the balance-sheets of manufacturing firms would in some cases be likely to show very different results. As it is, it is notorious that comparatively few of the leading American iron-making corporations have been making large profits, and that some of them have incurred heavy losses. I am aware that there are notable exceptions,—or, rather, one notable exception, that has made really handsome profits, due to an efficiency of administration and a singleness of purpose rarely equalled in manufacturing annals.

I am only too well aware that I have but touched the fringe of a very large subject. But even so, I venture to hope that the facts and suggestions submitted may have tended to shed an increased light on what is unquestionably one of the most important questions of the day, the settlement of which must largely affect the prosperity of large parts of the world's surface, both now and in the distant future.

ERRATA.—Owing to my having been unable to revise the proofs, several clerical errors crept into my article in the issue of December, 1897. At p. 400, line 10, the cost of the Meurthe-et-Moselle ores should have been stated at 2s. per ton, and on p. 401, line 21 from bottom, the word "less" should have read "more."

EUROPEAN SEA-GOING DREDGES AND DEEP-WATER DREDGING.

By E. L. Corthell.

I.—TYPES OF APPARATUS AND COSTS OF OPERATION.

THE commercial requirements of the last half century, the competition of country with country, route with route, port with port, rail with water, all over the civilized world, have made it more and more important to supplement natural forces by artificial appliances, in order to remove the obstructions to a commerce increasing so rapidly in tonnage and size of carriers.

The vast benefits to commerce conferred by the mechanical ingenuity of man, producing great and economical tools for this important work, can scarcely be over-estimated.

To one at all familiar with the existing conditions in the United States and Europe, a great contrast is apparent. The former country, although possessing an extensive line of sandy coast (nearly all sand, except in a few localities), a coast indented with bays and supplied with estuaries and rivers penetrating often far into the interior, and capable of great commercial development, has, in spite of all these favorable conditions, done comparatively little to improve them.

There is scarcely one large manufactory of dredging-plant in the whole country prepared to build modern, effective, sea-going dredges. Most of those built are of the inland type, dipper or clam-shell or mud pumps. The backwardness and lack of suitable sea-going dredges and of manufacturing plant correspond remarkably well with the lack of harbor terminal facilities so ably shown by Mr. Crowell in recent numbers of THE ENGINEERING MAGAZINE.

The attention of the army engineers who have charge of river and harbor improvement in the United States has of late years been given to the subject, and the government no doubt will have at command, in course of time, dredges comparing favorably with those manufactured in Europe. The Mississippi river commission is also working to meet the requirements on that important river, where it has been found necessary to supplement works by dredging in order to supply commerce with the depth needed for navigation at low water.

There is one suction-dredger in the United States which deserves mention. In 1876 Mr. Jas. B. Eads, then engaged in building jetties at the mouth of the south pass of the Mississippi river for the purpose of deepening the channel from 9 feet to 30 feet through the bar lying outside in the Gulf of Mexico, designed *de novo* a powerful

dredger, which, though the hull was built at Pittsburg on the Ohio river, and consequently is not a sea-going dredger, is able to work in a considerable seaway, and has been to sea as far as Pensacola, Florida, to work on the sea bar there. This dredger was at the time one of the largest in the world, and had one of the largest centrifugal pumps, 6 feet in diameter with an inlet pipe 30 inches in diameter. It carried its own dredgings to sea in hoppers in the hull holding about 500 cubic yards. In free material, and with the depositing ground not more than two miles distant, it could dredge in ten working hours about 5,000 cubic yards of solid matters, and deposit them.

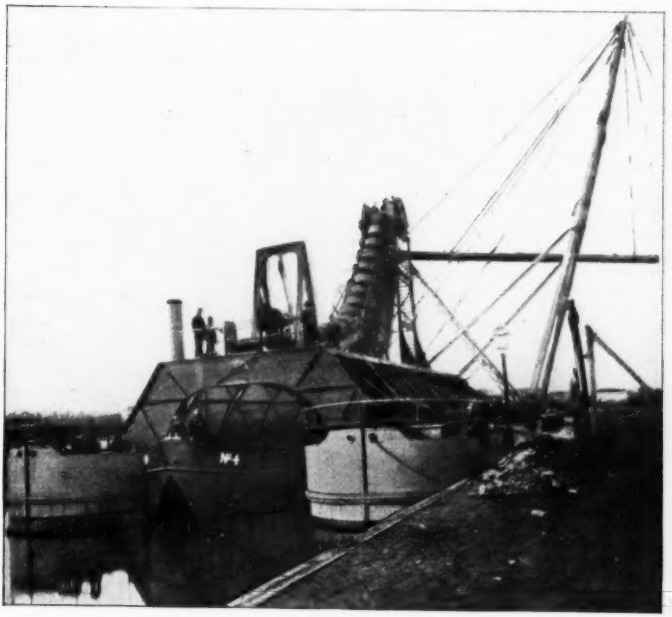
The purpose of this dredger was not to excavate the channel, but to hasten a development going forward by natural forces, which the jetties were bringing to bear upon the bar. It is a fact that, of all the material removed to make the channel, the dredge-boat removed less than one per cent. This boat has now been in use more than twenty years, not enlarging, but rectifying or shaping, the channel to conform to the three dimensions of the law,—*viz.*, 26 feet deep below average flood tide (the average range of tide is only 14 inches), with a width at that depth of 200 feet and a central depth of 30 feet.

Although there is not, as stated above, any manufacturing plant in the United States engaged in building over-sea dredges, the present customs law practically prohibits the introduction of these from any other country, the duty being 45 per cent. ad valorem. It has even been decided to be against the law to send a dredge-boat up from a Mexican port to do any work at any of the gulf ports of the United States, without paying this heavy duty. Consequently, being debarred from the use of any foreign dredges or from building any in foreign yards, the engineers, contractors, railway companies, ports, and the government itself, must simply go without them.

It is my purpose here to give briefly (1) the history of dredging and dredging appliances; (2) descriptions and illustrations of some characteristic dredges of the various types, and of their use, way of handling, capacity, and output, and some idea of the extensive use of dredges in Europe, and in countries dependent upon European manufacturers for dredging appliances; (3) the cost of dredging under varying conditions; (4) the conditions under which dredging has been successful from physical, economical, and commercial points of view, and, conversely, when it has been, or would be, unsuccessful; (5) some instances of the commercial benefits of dredging.

HISTORICAL DEVELOPMENT.

We can find an example of dredging as far back as 1591. This appears to be the earliest recorded. It consisted of two pontoons lashed together, yet held far enough apart to allow two spoons to



FLOATING ELEVATOR WITH LONG DELIVERY SHOOT.
Supplied to the Sanitary Works of Paris in 1887 by the Ship-Building and Engineering Co. "Werf Conrad," Ltd., Haarlem, Holland.

work in opposite directions. Iron buckets were first attached to an endless chain in about 1750, in raising material from foundations at Dieppe and for a bridge at Orleans.

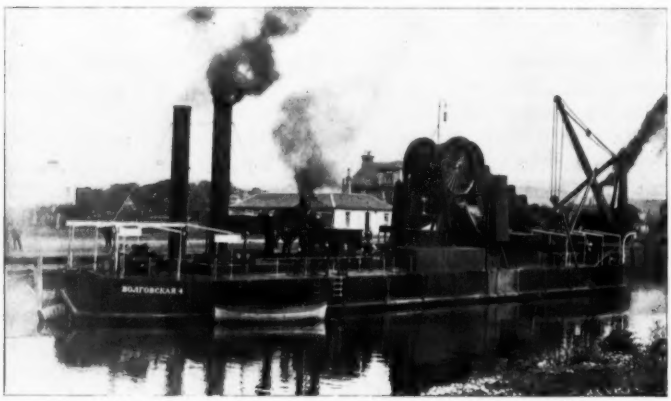
In 1797 Boulton and Watt applied a steam engine to a dredger, to clean out the harbor of Sunderland. This was a very small affair, but was a precursor of much more powerful dredgers. The engine was only of four h. p., and was placed in a flat-bottomed scow about 60 feet long, 20 feet wide, and 6 feet deep, with a draft of 4 feet. The engine and all the machinery weighed only 23 tons. It worked four spoons, each of which would raise a ton 10 feet in one minute.

Well-known engineers, such as Trevithick and Rennie, figure in the development of the dredge, for in 1802 the latter made some improvements on an appliance previously invented by the former; but in 1806 the former was bold enough to enter into a contract with the Trinity Board to remove 500,000 cubic yards per annum for twenty-one years from the bed of the river Thames.

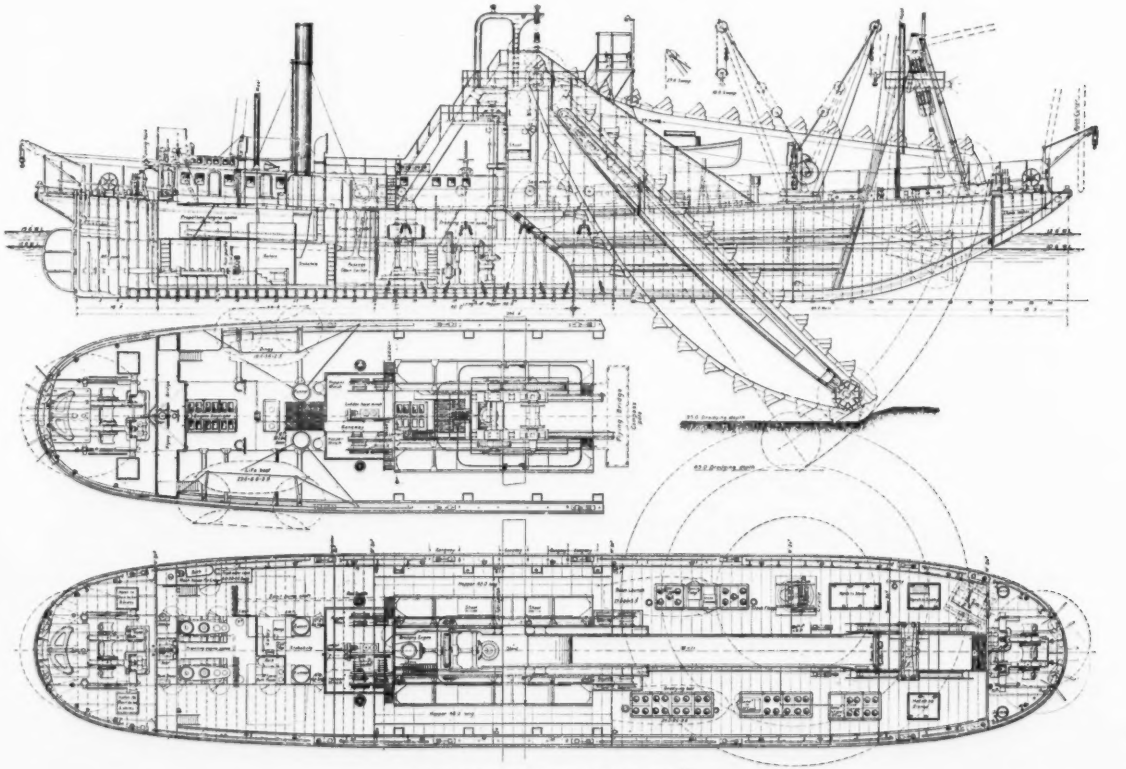
In 1861 two "hopper steamers" were built for use on the Clyde; each could carry 200 tons. In the same year, Messrs. Wm. Simons & Co., of Renfrew, constructed an iron screw-propelling hopper barge of 300 tons' capacity. This was the first "steam hopper barge."

Probably the first successful attempt at suction-dredging was on the construction of the Amsterdam canal in 1867, where a centrifugal pump was fitted to an old bucket dredge. A vertical shaft, driving a "spinner" 3 feet 6 inches in diameter was fitted near the bottom of an upright cylinder 12 feet high, so arranged that the contents of the buckets falling through it were met by the ascending column of water from the centrifugal pump. This liquefied the silt, and it was forced to the shore through wooden pipes placed on buoys, or floats. These pipes were connected by leather joints, or sleeves. This machine could deposit, at a point 1,200 feet distant, 2,000 tons of solid matter to a height of 8 feet above water-surface in 12 hours. Three years later double machines of this kind were used on canal work at Cronstadt, Russia. Attached to the vertical shaft of this machine, however, were water jets under high pressure, which were directed into the cylinder. By this means stiff clay could be sufficiently broken up to be moved ashore. This kind of machine was afterwards employed on the Danube.

Ten years later (1880) a combined bucket and pump dredger was built in England. This came nearer to the dimensions of more modern dredgers. It was 124 feet long, and 28 feet beam, and the buckets held 18 cubic feet. It would dredge to a depth of 28 feet. The



COMBINED BUCKET AND SAND-PUMP DREDGE "VOLSHSKAIA."
138x25x9 ft.; combined lifting capacity per hour, in free soil, 9,480 cu. ft.; Wm. Simons & Co., Ltd., Renfrew.



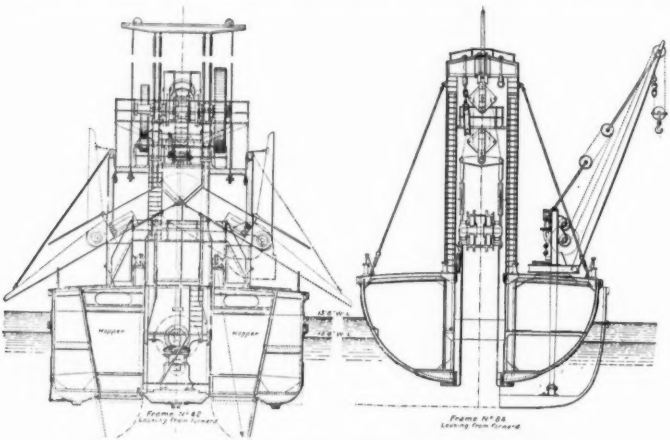
SOLID-ROCK DREDGER "MAJESTIC."

208½x39x17¾ ft.; hopper-capacity, 14,000 cu. ft.; 800 i. h. p. propelling engine and 1000 i. h. p. for dredging machinery; maximum depth dredged, 45 ft. She is fitted with rock-breaker, bucket ladder apparatus, and centrifugal spoil-pump for soft dredging.
Built by Lobnitz & Co., Renfrew, Scotland.

centrifugal pump was 4 feet 6 inches in diameter, and the discharge pipe 18 inches. The suction pump dredger was next applied to steam hopper barges, and used at the ports of Rotterdam and Amsterdam. Such barges were then, in many places, fitted with suction pumps.

TYPES AND THEIR USE.

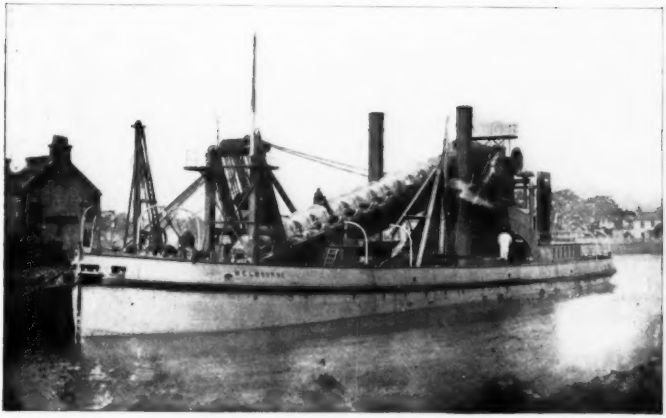
(1) Bucket dredgers, with single and double ladders, and buckets of various sizes and kinds, working on an endless belt, the bucket ladder working in some cases through a bow-well, in others through a stern-well: (*a*) loading into barges alongside; (*b*) loading into their own hoppers in the hull of the boats, or into barges alongside (then styled a "hopper bucket dredger"); (*c*) discharging into a hopper on top, at the summit of the run of endless belt, where a jet



CROSS SECTIONS OF THE SOLID-ROCK DREDGER "MAJESTIC."

of water from a pump lubricates the material and forces it into long shoots or pipes, which are supported from a mast and reach over the banks ashore, where, by an extension of its pipes, the material is carried a considerable distance and deposited on the land. The height of this elevated hopper is sometimes more than 60 feet above the deck of the boat. Some very powerful dredgers of this kind were used on the Panama canal by the American Dredging Company, and these were built at Jersey City, opposite New York. Several great dredgers of this kind were used by Messrs. Pearson & Sons on the drainage canal of the City of Mexico, and they have been used extensively on the Rotterdam waterway and elsewhere.

(2) Sand pump dredgers. These are either barge loading or hopper



BARGE-LOADING DREDGE "MELBOURNE."

200x35x11½ ft.; lifting capacity per hour, in free soil, 18,750 cu. ft.; maximum depth dredged, 35 ft.; Wm. Simons & Co., Ltd., Renfrew.

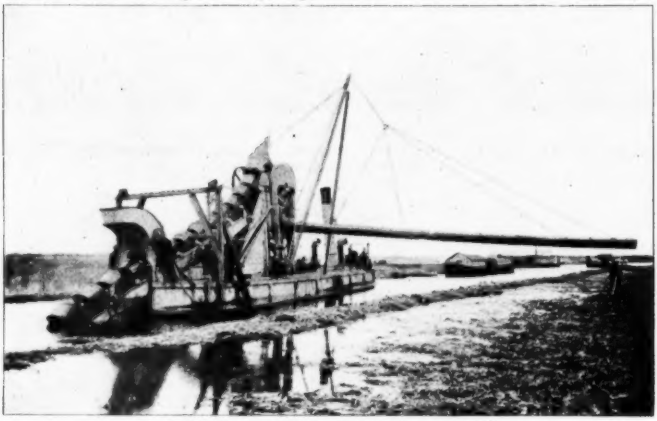
HOPPER AND BARGE LOADING DREDGE "SIR JOHN GOODE."

210x40x15 ft.; hopper-capacity, 19,000 cu. ft.; lifting capacity per hour, in free soil, 17,400 cu. ft.; Wm. Simons & Co., Ltd., Renfrew.

dredgers. Some have two pumps and two suction pipes; others, one only. Some are for inland work, and some are seagoing.

(3) Combined bucket and sand pump hoppers: generally seagoing, and for ports or mouths of rivers where there is a variety of materials, some of which are more easily moved by the buckets and some by the pump; the former, generally clayey materials, the latter soft mud and sandy materials. Soft mud is easily removed by the pump; but, on account of its very light specific gravity and great fineness, it settles so slowly in the hoppers that a great deal of it is wasted overboard through the overflow weirs.

(4) Mud pump. This is an apparatus for sending ashore, under the force of a strong water pump, material which has been raised by a



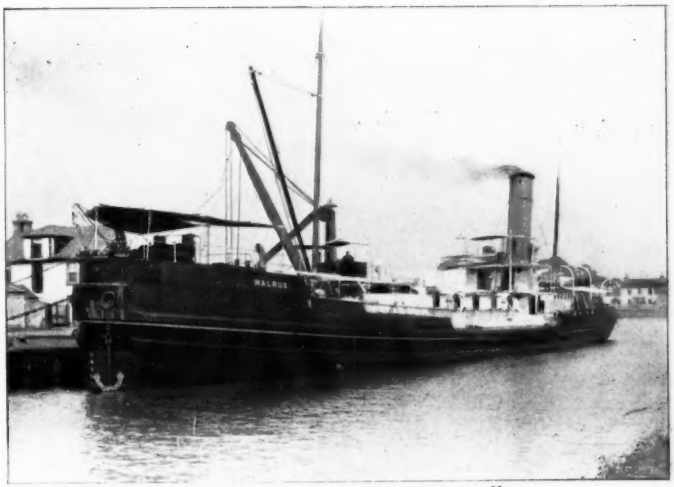
DREDGER WITH LONG SHOOT, "LA CRAU."
Built in 1883 for the drainage works of the Marais de Fos, southern France, by the Ship-Building and Engineering Co. "Werf Conrad," Ltd., Haarlem, Holland.

bucket or suction dredger, the mud pump being usually placed alongside the dredger, or taking the material out of a barge alongside.

(5) Grab bucket hopper. This is usually a sea-going vessel for depositing from its own hoppers, and may have two, four, or more grabs of the Priestman, or clam shell, class. These grabs are worked by cranes which swing outboard, drop the grab to the bottom, and then, raising it loaded, drop the contents into the hoppers.

(6) Hopper barges, into which material is deposited from a bucket dredger or sand pump, when it is towed to sea by a tug, which may take one or more barges in tow.

(7) Hopper steamer, a hopper barge with its own propelling power. The material is deposited in its hoppers by a bucket or sand pump dredger; it takes the load to sea, and discharges it.

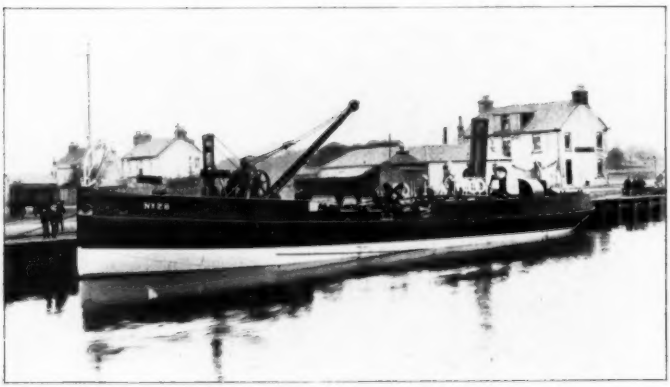


SAND-PUMP HOPPER DREDGE "WALRUS."

210x36½x15½ ft.; hopper-capacity, 26,000 cu. ft.; lifting capacity per hour, in free soil, 48,000 cu. ft.; Wm. Simons & Co., Ltd., Renfrew, Scotland.

COMBINED BUCKET AND SAND-PUMP DREDGE "NO. 10."

138x25x9 ft.; hopper-capacity, 25,180 cu. ft.; lifting capacity, per hour, in free soil, pump, 10,750 cu. ft., buckets, 20,900 cu. ft. Wm. Simons & Co., Ltd., Renfrew.



GRAB-BUCKET HOPPER DREDGE "NO. 76."
210x23x9½ ft.; hopper-capacity, 3,300 cu. ft.; lifting capacity per hour, in free soil, 3,050 cu. ft.
Wm. Simons & Co., Ltd., Renfrew, Scotland.

There are peculiar and interesting modifications and varieties of nearly all these principal classes forming special types. There are bucket dredgers with transporting belt to carry the material ashore. Many of the bucket dredgers are dismountable for ocean voyages. There are floating elevators which are anchored in the stream or near the banks of a river, and the barges of material dredged by some other method elsewhere are brought alongside, when the elevator re-dredges out of these barges, and delivers the material ashore, often at a considerable distance. There are even stationary elevators on piling or trestle work for the same purpose, and the barges in such cases have no bottom doors, the material being dredged out of their holds.

To the above classes should be added the ordinary single dipper and clam-shell dredges so largely used in the United States, and the Priestman dredger, on the same general principle. The powerful dipper and Priestman dredgers on the improvement at and near the "Iron Gates" of the lower Danube did, and are doing, good work in removing the *débris* of the blasting operations at the rocky bottom, though the most effective machines there are the great ladder bucket dredgers designed especially for handling large masses of broken rock in the swift currents of the Danube.

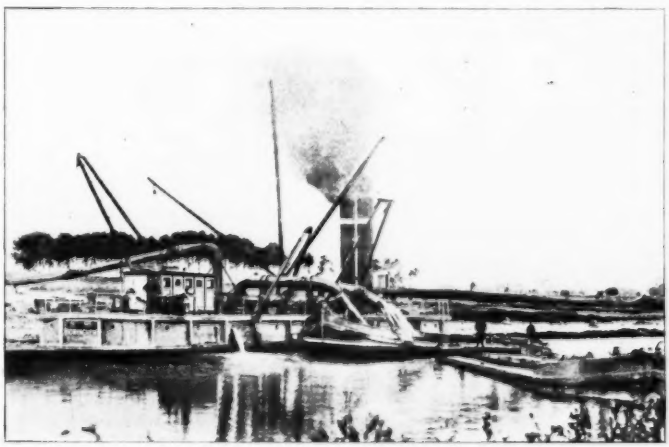
EXAMPLES OF DREDGERS.

The writer has been able to present illustrations in the way of photographs, through the courtesy of two of the leading manufacturing companies of Europe, Messrs. Wm. Simons & Co., Ltd., of Ren-

frew, Scotland, and the "Werf Conrad" Company, of Haarlem, Holland. There are other well known manufacturers, like Lobnitz & Co., of Renfrew, and J. Smit & Son, of Kinderdijk, Holland, whose output has been very great, and who are known all over the world. By special request Messrs. Simons & Co. presented the writer with many photographs of characteristic dredgers, and a tabulated statement, giving some of the more important particulars.

During thirty-two years Wm. Simons & Co. have constructed dredgers of a great variety of types, for eighteen governments, thirty-two companies and harbor boards, and ten railway companies. The dredgers were destined for seventy-eight different places. An analysis of the list of dredgers built gives 36 barge-loading bucket dredgers; 71 bucket hopper dredges, either bow-well or stern-well, six of which were fitted with sand pumps; 12 sand-pump hopper dredgers; and 62 steam hopper barges. The Werf Conrad Co., in thirteen years, have built 61 bucket dredgers, of which 30 were supplied with mud pumps; 24 sand pump dredgers, of which 15 were supplied with mud pumps; 6 mud pumps; 5 elevator dredgers; 3 excavators; and 69 hopper barges. These were built for forty-five contracting companies, three railway companies, nine harbor boards, one city, and five governments. They were used in twenty-one different countries.

The list of large dredgers would not be complete without a brief reference to the two largest in the world, designed for and now working on the Liverpool bar, eleven miles at sea. The description of one



PUMP DREDGER FOR EMPTYING BARGES.
Built by the Ship Building and Engineering Co. "Werf Conrad," Ltd., Haarlem, Holland.

SAND-PUMP HOPPER DREDGE "OCTOPUS."

215x36½x15¾ ft.; hopper-capacity, 1,300 tons; lifting capacity per hour, 3,000 tons of sand; Wm. Simons & Co., Ltd., Renfrew.

will fit the other, with some minor exceptions. The hull is 320 feet by 47 feet by 20½ feet deep. The loaded draft is 16 feet. There are two centrifugal pumps, each 6 feet in diameter. Each has a 36-inch pipe. These unite into a 45-inch pipe hung by a ball and socket joint on a trunnion, so as to work safely in a seaway when waves are 10 feet high. This suction pipe is 76 feet long, so as to allow dredging in 53 feet of water. There are eight hoppers, holding in all 3,000 tons of material, equivalent, when solid, to about 2,000 cubic yards. The hoppers can be filled with solid matter in three-quarters of an hour, and the load can be discharged in five minutes. These and companion dredgers have moved from this sea-bar more than 17,000,000 cubic yards of solid earth. The dredgers cost about £36,000 each.

Some details of another and somewhat similar dredger will be of interest. One of the most effective sand pump hopper dredgers is the "Octopus" (see photograph), built by Wm. Simons & Co., and a duplicate dredger of the same style and size, used at the same place (Natal, South Africa) and in the entrance to Durban Harbor, which is exposed to sudden and damaging silting-up outside the jetties. The vessel is 215 feet long, 36 feet 6 inches in breadth, and 15 feet 9 inches in depth, and the hopper has a capacity of 1,300 tons. The two centrifugal sand pumps, 33 inches in diameter, will raise 3,000 tons of sand per hour, working to a depth of 40 feet under water level. The sea-bar at Durban shoaled up in a storm to a depth of 5 feet in

the south channel. The Octopus in three days (really fourteen hours' working time) dredged a channel through to water 13 feet deep at low tide, discharging, however, most of the spoil over the side.

THE COST OF DREDGING.

This varies as the conditions vary, and they are almost infinite. Referring first to the Liverpool sand pump dredgers described above, the facts are as follows. The sand dredged weighs about 124 pounds per cubic foot. Sixty per cent. of the mass drawn up is solid sand. The cost of pumping it, carrying it four miles to sea, discharging it, and returning it to the dredging ground is 1½ cents per ton,—2⅓ cents per cubic yard,—counting everything except interest and depreciation of plant. The cost of dredging with the "Octopus," also described above, is about 1½d. per ton, or 2¼d. per cubic yard, working in free sand and depositing the dredgings from one to two miles at sea. This cost includes insurance, interest on cost, and maintenance. The writer has obtained a consensus of opinion as to the cost of dredging by bucket dredgers under ordinary and favorable conditions. The average is about as follows:

Barge loading dredger, dredging in free soil (raising only), average cost say 10s. ($2.43) per 100 cubic yards, including working expenses, wages of crew, coal and stores, and repairs (5 per cent. on capital).

Steam hopper barges (hopper steamers), conveying the spoil about eight miles to sea ..	2¼d.	per cubic yd.
Add dredging-cost by barge-loading dredger	1d.	" " "
	3¼d. (6½c.)	" "

BUCKET DREDGER WITH MUD PUMP.
Built by the Ship-Building and Engineering Co. "Werf Conrad," Ltd., Haarlem, Holland.

say 32s. 6d. ($7.90) per 100 cubic yards for dredging by barge-loading dredger and depositing by steam hopper barge.

Hopper dredger, dredging and conveying the spoil about eight miles to sea, 2½d. (5c.) per cubic yard, say 25s. ($6.08) per 100 cubic yards.

"No. 344" Grab Crane, named "Miles K. Burton" (see page 24), raised and deposited at sea at Liverpool eleven loads of about 1,450 tons each—15,950 tons (one load removed each tide), with double shift of hands. Her working expenses, for wages of crew, fuel, and stores, were less than 1d. per ton, or 1½d. per cubic yard, of spoil raised, and discharged twelve to fifteen miles off at sea. This dredger is equipped with five hydraulic cranes furnished by Armstrong's. The grabs worked by them are "Morgan's" patent, somewhat similar to Priestman's, with improvements.

In the river above and below Rotterdam the total cost of suction (sand pump) dredging, as per the contractor's price, is about 1.9d. per cubic yard. This is done with hopper barges, with a distance to dumping-ground of 3½ to 4 miles. Some of these dredgers have a large output, one of them handling, in a contractor's day, 6,000 cubic meters—7,850 cubic yards.

At Ymuiden, the harbor of the Amsterdam canal at the North sea, where about 700,000 cubic yards are annually dredged,—some in the sea, some in the approach to the locks, but mostly in the harbor channel,—the cost is about 5d. per cubic yard; but one cause of the larger cost is the inability to work at at all times on account of the waves. The above is for dredging simply; if transporting, interest, and depreciation be included, the cost is increased as follows:

By bucket dredger, 4.63d.
Transport 2 miles, 3.70d. } 8.33d. (16⅔c) per cubic yard.

By sand pump dredger, 3.65d.
Transport, 3.59d. } 7¼d. (14½c.) per cubic yard.

At the Hook of Holland about the same amount of dredging is required outside and in the jetty channel, and the cost is about the same; both bucket and suction dredgers are used in both harbors.

In the river Tyne, from Newcastle-on-Tyne to Tynemouth, where, since 1838, about 100,000,000 tons of material have been dredged, largely to deepen and widen the channel of the Tyne, the cost has averaged about 3.6d. per cubic yard, various kinds of dredgers being employed. On the river Tees, where also a large amount of dredging has been done, the cost averages about 4½d. per cubic yard.

In the Belfast new channel, with bucket hopper dredgers, where 5,000,000 cubic yards were removed, the cost was about 3d. per cubic yard, including interest and depreciation. The depositing ground

was ten miles distant. The average cost, with hopper bucket dredgers in mud, sand, clay, and some stiff material, at Bombay, Blyth (east coast of Scotland), Belfast, and the Clyde, with an average transportation of nine miles, is 4¾d. per cubic yard.

At Sydney, a suction dredge, forcing sand ashore 1,800 feet and mud twice that distance, dredged more than 2,000,000 tons at a cost of less than 2½d. or 3¾d. per cubic yard; and another, which dredged about 2,500,000 tons, did work under similar conditions for 2d. per ton, or 3d. per cubic yard.

At Calais and Boulogne, suction hopper dredges, dumping two miles at sea, dredge at a cost of 2½d. per cubic yard at the former place, and 3⅓d. at the latter. This includes all expenses, except interest and depreciation. The analysis of cost of the Boulogne work is as follows: wages, 27 per cent.; coal, 28 per cent.; stores, 9 per cent.; repairs and maintenance, 36 per cent.

At Dunkirk, dumping three miles at sea, the cost is as follows, not including interest and depreciation:

By bucket dredges—

Dredging .... 1.93d.
Transport .... 2.00d. } 3.93d. per cubic yard.

By sand pump in the sea channel and 2½ miles to dump 1.46d. per cubic yard.

To ascertain cost, including interest and depreciation, 10 per cent. is usually added. The analysis of this work is interesting.

Dredging:

	pence per cu. yd.	Transport.
Wages	0.527	0.216
Coal	0.264	0.119
Oil and sundries	0.184	0.025
Repairs	0 055	0.066
	1.030	0.426

Total (as above) ..... 1.46d.

On the Clyde, by bucket dredgers, transporting 7 miles in hopper barges: the dredging cost ..... 2.54d.
the transport " ..... 2.47d.

5.01d. per cu. yd.,

including interest and depreciation.

One of the most effective and economical dredges is the Von Schmidt, named after the inventor and patentee, of San Francisco. Some very good work has recently been done by one of these dredges, embodying all the latest improvements of this type. A brief descrip-

tion will be of interest. It is called the "Groper," and is at Sydney, New South Wales. The hull is 115 feet by 50 feet by 9 feet; one end is square, the other semicircular. The pump, with a shrouded cast-iron "spinner" 7 feet 6 inches in diameter in a wrought-iron casing, has a speed of from 100 to 130 revolutions, according to the distance the materials are to be carried. The machinery for cutting the clay or other material is fixed on a strong platform, traversing on rollers from side to side of the dredge at the semi-circular end. The pump ascends at the center and outer end, and can move around horizontally with the travelling platform. The pipe is arranged telescopically for varying depth. Outside of it is a vertical shaft, to the lower end of which is attached a horizontal cutter 8 feet in diameter,

GRAB-BUCKET HOPPER DREDGE "MILES K. BURTON."
225x38x17 ft; hopper-capacity, 30,000 cu. ft.; lifting capacity per hour, in free soil, 28,800 cu. ft.; built by Wm. Simons & Co., Ltd., Renfrew, Scotland.

armed with steel knives. The material cut by these is swept up by the action of the pump, and forced on pontoons to the land. The writer of the article from which the above is abstracted states: "So effective is the cutting mechanism that a Von Schmidt dredge can cut its way into a bank 3 feet above high water, just as readily as it can deal with stiff clay, or even soft rock, at a depth of from 12 to 20 feet."

This dredge cost about £20,000, of which £8,000 was paid for the "Von Schmidt" pump and machinery and the royalty for using it. Much of the material is dumped alongside the dredge from other dredges. The cost according to distance ashore is 1¾d. to 2½d. per ton. The average cost of all work at Sydney with pump dredges

PARTICULARS OF SOME CHARACTERISTIC BRITISH-BUILT DREDGES.

	Name.	Yard No.	Class.	Dimensions.	Draft.	Hopper Capacity.	Max. Depth Dredged.	Lifting Capacity per hour in free soil. (cubic feet.)
1	Melbourne.	243	Barge Loading.	200′ 0″×35′0″×11′ 6″	8′0″	Finished Nil	35′0″	18,750
2	Francis Henty.	270	do	146′ 6″×32′0″×11′ 6″	6′6″	do Nil	35′0″	12,250
3	Lyster.	341	do	189′ 9″×35′6″×13′ 0″	9′9″	do Nil	45′0″	15,900
4	St. Austell.	330	do	192′ 0″×35′6″×13′ 0″	8′9″	do Nil	46′0″	16,100
5	Sir John Coode.	335	Hopper & Barge Loading.	210′ 0″×40′0″×15′ 0″	Light 8′8″	Loaded. 11′6″ 19,000 cu. ft.	36′0″	17,400
6	St. Michael.	309	do	180′ 0″×36′0″×15′ 6″	10′0″	12′6″ 12,600 “	45′0″	9,500
7	Cornwall.	342	do	195′ 6″×37′0″×15′ 6″	8′6″	12′0″ 13,200 “	46′0″	9,500
8	Mermaid.	280	do	191′ 0″×38′0″×15′ 9″	8′0″	12′6″ 20,000 “	35′0″	12,680
9	Walrus.	346	Sand Pump Hopper.	210′ 0″×36′6″×15′ 7″	8′9″	13′0″ 26,000 “	35′0″	48,000
10	Kate.	343	do	200′ 0″×39′0″×14′ 6″	8′0″	12′0″ 20,500 “	40′0″	30,000
11	Jupiter.	297	do	160′ 0″×32′0″×11′ 6″	6′6″	10′0″ 12,300 “	35′0″	21,000
12	No. 1.	300	do	145′ 0″×28′0″×12′ 3″	5′6″	10′0″ 11,200 “	35′0″	9,600
13	Percy Sanderson.	319	Combined Bucket and Sand Pump Hopper.	220′ 0″×40′0″×17′ 2″	8′3″	13′6″ 25,180 “	35′0″	10,750 Pump 20,900 Buckets
14	No. 1.	299	do	200′ 0″×46′0″×15′ 0″	9′6″	12′6″ 20,000 “	35′0″	10,750 Pump 22,900 Buckets
15	No. 10.	318	do	187′ 0″×35′6″×14′10″	8′3″	11′6″ 14,300 “	35′0″	14,450 Combined
16	Volshskaia.	320	Combined Bucket and Sand Pump.	137′10″—24′8″× 9′ 2″	3′4″	Finished Nil	12′6″	9,480 Combined
17	No. 76.	311	Grab Bucket Hopper.	110′ 0″×23′0″× 9′ 6″	5′0″	7′0″ 3,300 cu. ft.	40′0″	3,050
18	Miles K. Burton.	344	do	225′ 0″×38′0″×17′ 0″	8′6″	13′6″ 30,000 “	47′0″	28,800
19	No. 21.	314	Hopper Steamer.	200′ 0″×35′0″×15′ 6″	6′6″	13′6″ 24,900 “		
20	No. 4.	336	do	155′ 0″×28′6″×12′ 6″	5′6″	9′6″ 10,300 “		

Table No. I.

	Work done in one year by two 650 ton Stern-Well Hopper Dredges (A and B).		Work done in one year by one Barge Loading Dredger (C) and three 600 ton Hopper Barges (D).	
	A.	B.	C.	D.
Number of days dredging.....	265	268	224	
Average number of hours per day,.	10¼	10¼	10¼	10¼
Number of crew.....	16	16	16 (40 in all.)	8 each.
Total quantity dredged and conveyed to sea.....	*386,410 tons	*336,500 tons	†676,053 tons for	dredger and barges.
Average per day.....	1,458 tons	1,255 tons	3036 tons	
Average time to load.....	1½ hours in soft material 3 " hard "	Same as A	1½ hours in soft material 3 " hard "	to raise 500 tons.
Average cost per week for wages, coal, and stores.....	£94.3.9 ($458.80)	for *both* dredges.	£95.14.6 ($466.20)	for dredger and barges.
Average cost per week for wages, coal, stores, and repairs.....	£114.15.6 ($558.90)	for *both* dredges.	£125.13.5 ($612.00)	for dredger and barges.
Cost per ton of material dredged and conveyed to sea.....	1.981*d* (4c) per ton,	or 3*d* (6c) per cu. yd.	2.172*d* (4.33c) per ton,	or 3.25*d* (65c) per cu. yd
Cost per ton of material dredged and conveyed to sea, including 5 per cent. on capital.....	2.698*d* (5.4c) per ton,	or 4*d* (8c) per cu. yd.	3.062*d* (6c) per ton,	or 45*d* (9c) per cu. yd.

* Nearly the whole of this was *very hard* clay.

† About one-half of this was *free* soil, the remainder *earthy clay*.

TABLE No. II. DATA OF COSTS OF DREDGING, DERIVED FROM ACTUAL WORK.

in harbor, rivers, and channels, moving about 11,000,000 tons, was 2½d. per ton, or 3¾d. per cubic yard.

At Oakland, where the Von Schmidt dredge is largely employed for deepening the harbor, the cost per cubic yard is about 3¾d. per cubic yard. At the Sulina outlet of the Danube, in a new cut made to rectify the channel, 7,751,000 cubic yards were moved and put mostly on the land for 2⅛d. per cubic yard. This material included hard clay, heavy sea-sand, fine sand, and light silt. It was learned on this work that, when very hard clay was encountered and could be pumped ashore only with difficulty, increasing the speed of the pumps from 225 to 275 revolutions would move almost any material, and prevent it from settling in the pipes.

TYPE OF PLANT.	Place.	Distance material conveyed, miles.	Cost, excluding interest and depreciation.	Cost, including interest and depreciation.
Dredger "Clyde" and three 500-ton steam hoppers[1]	Port-Glasgow,	7 to 8		
Dredging				1.85
Depositing				1.83
Bucket ladder dredger and steam barges	Liverpool,	7 to 8	3.63	3.68
Bucket ladder dredger "Teredo" and three 460-ton steam barges[2]	Bombay,	4 to 5	2.20	
Dipper dredger No. 9, 1000 tons[3]	Liverpool,	7 to 8	1.78	
" "Pholas," 500 " [4]	Bombay,	4 to 5	4.10	
Hopper dredger No. 3, 850 " [5]	Belfast,	10	1.92	3.27
" No. 4, 850 " [6]	"		1.80	3.15
" "Forth," 800 " [7]	Grangemouth,	18	2.00	
" "Leven," 800 " [8]	Blyth,	2	1.03	
" "Kuphus," 1000 " [9]	Bombay,	4 to 5	1.50	

[1] A year's work. [2] A year's work. [3] Day and night. [4] A year's work. [5] Over three years' work, day and night. [6] Over three years' work, day and night. [7] Working tides. [8] Day and night. [9] A year's work.

PARTICULARS OF COST OF DREDGING.

Taken from a paper on "Dredging and Dredging Appliances," read March 26, 1889, before the Institution of Engineers and Shipbuilders in Scotland, by Mr. Andrew Brown.

Many other instances of cost of dredging might be given; but the above are sufficient to show that the average cost is so small that this artificial method of improving and maintaining channel and harbor depths may be reasonably resorted to, where the conditions are at all suitable. This leads to the consideration, which will be taken up in the next number of THE ENGINEERING MAGAZINE, of the conditions under which dredging has been successful from physical, economical, and commercial points of view; and, conversely, where it has been, or would be, unsuccessful.

SYSTEMS AND APPARATUS FOR HEATING BUILDINGS BY STEAM.

By J. J. Blackmore.

THE art of heating buildings by steam has progressed so rapidly during the past ten years that there are now three distinct systems well developed, all performing the same kind of service, but doing it under conditions that vary materially. The oldest and most widely known of these is the gravity system, so called for the reason that the steam generated in the boiler rises up to the radiators, and, as it is condensed, the resulting water is returned to the boiler by gravitation, no appliance, other than the return pipe, being used for this purpose.

The next is what may be called the mechanical system, as mechanical means are frequently applied to reduce the pressure of the steam in the system from that carried in the boiler, and mechanical appliances are always used to return the water of condensation from the return pipes of the system back to the boiler. These may be in the shape of an automatic steam trap, or a pump and governor, as may best suit the conditions.

The third is the exhaust-steam system, in which the heating is done by steam that has been used to drive engines or pumps, and that would be of no further service if it could not be utilized as heat. In this system mechanical appliances are also used for controlling and directing the steam through the system. These appliances are back pressure valves, for the purpose of preventing too much back pressure on the engines; separators, to remove the oil or other impurities carried over with the steam from the engine cylinders; and traps, or pumps, with governors, to return the water of condensation to the boilers. This article will deal only with the first mentioned,—the gravity system.

Steam heating by gravity is almost always by low pressure,—*i. e.*, at a pressure of less than ten pounds as indicated by steam gauge. This pressure is considered absolutely safe, and on that account very few States of the union have made any laws for the inspection or supervision of low-pressure steam boilers. A well-designed gravity steam-heating apparatus, unless of large dimensions, will operate perfectly without indicating any pressure on the steam gauge, the pressure of the atmosphere being sufficient to exert all the force necessary to distribute the steam to the various radiators in a system.

The boilers used for low-pressure steam heating are mostly made of a cast iron of sectional form,—*i. e.*, a number of separate sections are bolted or screwed together to make a complete unit. These sec-

tions are made in two general types, — those that stand upright, with each section resting on the foundation, or base, and those that are horizontal in form, and set one on top of another. In Fig. 1 is shown the outline of the vertical type, giving a good idea of its shape and the method of connecting the sections. This form of boiler has many advantages over the horizontal type. It can be enlarged by adding additional sections. The grate area is enlarged as the sections are added. The joints connecting the sections are exposed to view, and the boiler can always be put together without the aid of packed joints. The vertical form is also better for steaming, inasmuch as the circulation is much quicker, and the steam can more quickly escape to the surface. Fig. 2 illustrates a boiler of the horizontal type, with the sections placed one above the other. Many of these give good results, but they do not admit of as strong construction as does the other type; they cannot be as easily enlarged, or as easily cleaned; and they are nearly always made with packed joints, which are liable to give out and need repairs. A very large number of boilers of this type have been sold, because of the magazine attachment, or self-feeder, with which so many of them are supplied. To a house-owner, this feature often appeals very strongly, but it is really of little advantage, as a surface-burning boiler will hold steam for ten hours, and more than that is not necessary. A magazine attachment is a detriment to the heating qualities of a boiler, as it takes up space that would be valuable as heating surface, and prevents the proper combustion of the fuel. Steel and wrought-iron boilers, of various forms, are also used for low-pressure heating. Those most in use are the tubular form,

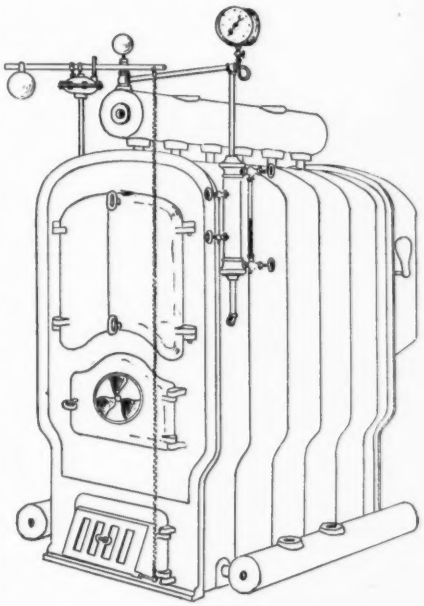


FIG. 1. VERTICAL BOILER.

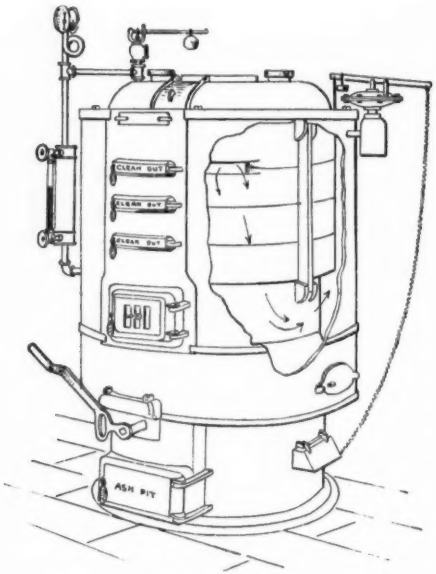


FIG. 2. HORIZONTAL BOILER.

both vertical and horizontal. For very large plants the tubular boiler has some advantages over the cast-iron sectional boiler. The large steam space makes the apparatus work more uniformly, and in large sizes they will work with greater economy, as the brick-work setting enables the heat to be carried into contact with all parts of the surface of the boiler, which cannot very well be done with a cast-iron type. This, however, does not apply to a boiler of less than forty horse power. The factor of safety is rather in favor of the cast-iron boiler, but the danger from explosion in a low-pressure boiler is so small that it hardly need be considered.

The fixtures used with a low-pressure boiler are shown in Figs. 1 and 2, and consist of a safety valve set to blow off at ten pounds, a steam gauge, a water gauge and column, draft regulator, blow-off cock, and sometimes an automatic water-feeder. The latter, however, is of doubtful advantage, as the quantity of water used in such an apparatus is very small. Wrought-iron and steel boilers are nearly always set up in brick work, while cast-iron boilers are generally protected only with a coating of asbestos cement or a galvanized iron casing.

There are two general systems of piping used in gravity steam heating, one being known as the two-pipe system, illustrated in Fig. 3. It has a complete system of feed pipes, and a corresponding run of return pipes, each radiator having two valves. The other is known as the single-pipe system, shown in Fig. 4. The single-pipe system may be put up in different ways. That shown in Fig. 4 is called the single-pipe circuit system, and is probably the best method to adopt for single-pipe work. In this application of the single-pipe system the water of condensation is carried in the direction in which the steam is flowing,

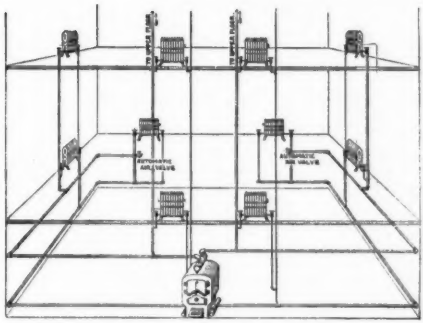


FIG. 3. DOUBLE-PIPE SYSTEM.

except in the case of the rising pipes, and is returned to the boiler with very little loss of heat. Fig. 5 shows another application of the single-pipe method, in which all distributing horizontal pipes drip towards the bottom of the rising pipes, where relief pipes are attached to carry the water of condensation back to the boiler. Fig. 6 represents still another form of single-pipe work, and it is considered by many engineers the best form for large plants. In it the main feed pipe is run to the upper part of the building, and the various branch pipes are carried to points where lines of radiators are to be placed. From here runs of pipe are dropped to feed the various radiators on the floors below. At the bottom of each line in the cellar a system of return pipes is connected to collect and return the water of condensation to the boiler. The steam in this system goes through the entire apparatus in the direction in which the water flows and on that account it has its advantages. The installation of any of these systems is attended with good results, if the work is properly done and the proper sizes of pipe are used for the required work, while any application will be a partial or complete failure, if care is not used.

The proper size of steam pipe for a given amount of radiation has been the subject of a good deal of attention among engineers, and a good many rules have been devised to give the needed size. An investigation of the rules given in the text-books now published shows a wide variation in the conclusions, the rules submitted by four writers varying as much as one hundred and thirty per cent.

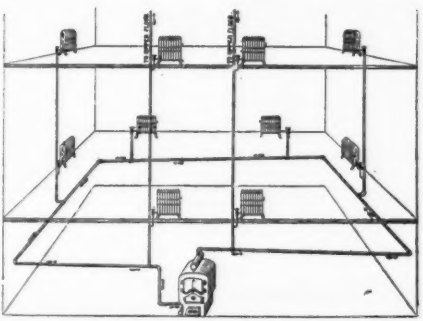


FIG. 4. SINGLE-PIPE CIRCUIT.

For some years I have thought that some

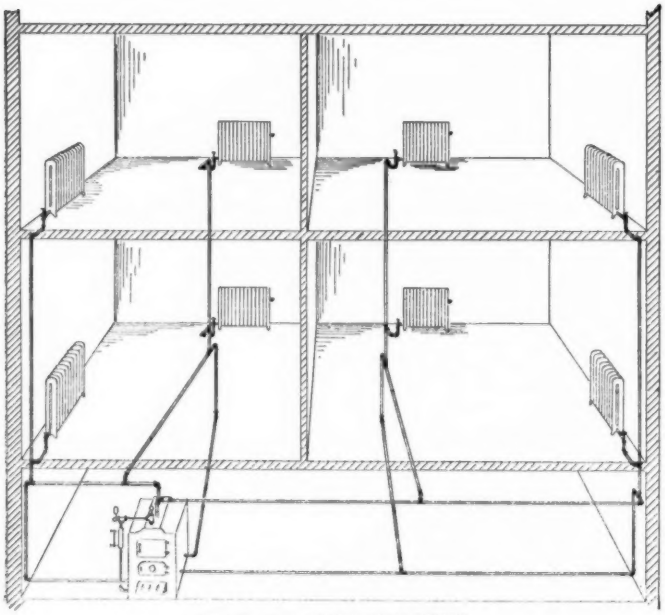


FIG. 5. SINGLE-PIPE DRIP RISERS.

simple rule could be devised that would give a proper ratio for all sizes of plant, and, with this end in view, I have made various observations from time to time to verify the correctness of the rule herewith submitted. It seems to accord very closely with the practice of many successful engineers. Almost all the rules heretofore given seem to have been the same for all sizes of plant. This is a mistake, as I find from close study that a different ratio is required for each size. A ratio satisfactory for a plant of 2,500 feet of radiation is not satisfactory for one of 800 feet.

To determine what is necessary to supply one hundred feet of radiation through one hundred feet of feed-pipe, we will consider the following points. One foot of radiation will lose about 255 units of heat per hour when exposed in a room at 70°. This makes a total of 25,500 units for 100 feet. As there are 966 units of heat in one pound of steam, at atmospheric pressure, we have to supply 26.4 pounds of steam per hour. Now, as there are 26.37 cubic feet of steam to a pound, we have to supply 696 cubic feet of steam. If we did not have to allow anything for friction, we could pass 766 feet of steam per hour through a 1¼-inch pipe at a velocity of 25 feet per second;

but the losses by friction and condensation are so great under these conditions that we have to allow fully seventy per cent. to insure satisfactory results. Having satisfied myself of what was necessary to get good results in the case of 100 feet, I determined to adopt some constant to determine the ratio per one hundred feet of surface that would be accurate for any size of pipe. A further investigation led me to adopt the following simple rule to determine this ratio: $r = \frac{3.141}{d,}$ in which d is the diameter of the main steam pipe, and r the ratio needed in square inches for each one hundred feet of radiation in the system. To determine how much each size of pipe will carry we have this expression: $R = \frac{a}{r} \times 100$, in which a is the area of pipe, r the ratio as found in the former expression, and R the total amount of radiation the pipe will supply. From this we get the following table:

Size of pipe.	Ratio per 100 feet of radiation.	Area of pipe.	Amount of radiation each size will supply.	Size of pipe.	Ratio per 100 feet of radiation.	Area of pipe.	Amount of radiation each size will supply.
1½	2.10	1.767	84	6	.52	28.274	5440
2	1.57	3.141	200	7	.45	38.484	8550
2½	1.25	4.908	400	8	.40	50.265	12566
3	1.04	7.068	700	9	.35	63.617	18100
3½	.90	9.621	1062	10	.31	78.54	25300
4	.78	12 566	1590	11	.285	95.03	33200
4½	.70	15.904	2272	12	.26	113.09	43000
5	.63	19.635	3120				

The areas of commercial sizes of pipe are a little different from the circular areas given in the table. This does not affect the rule, but will change slightly the radiating surface corresponding to a size as given in the table.

For each one hundred feet that the main pipe is extended beyond the first hundred the ratio of the pipe next smaller should be used.

All horizontal steam pipes should have a regular fall in the direction in which the steam is flowing, a good fall being one inch in every ten feet. This will remove quickly all water of condensation, and prevent the cracking noises one so frequently hears in steam pipes.

It used to be considered necessary to have a distinct flow and return pipe to each radiator, in order to secure good results, and a good many engineers still cling to this idea, but it is a mistake. Water will return freely down a rising pipe, while steam is flowing up. The water of condensation clings to the inner surfaces of the pipe, and drips down, in much the manner that moisture runs down the sides of a water cooler filled with cold water in warm weather. A larger pipe is needed for single-pipe work than for double, but, if of proper size, one pipe will do the work with greater efficiency than two.

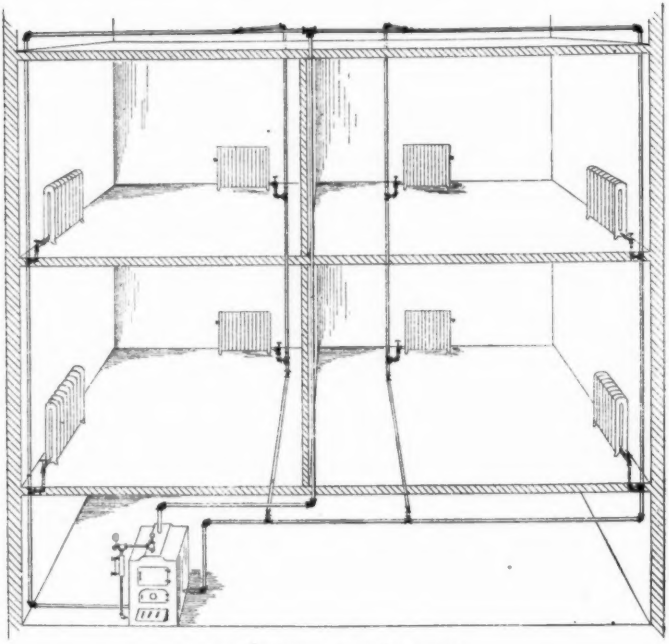


FIG. 6. SINGLE-PIPE TOP FEED.

The radiators used in steam heating, though of numerous patterns, may be classed under three distinct heads. The direct radiator, is made in a number of designs, and is intended to be set directly in the room to be heated. The semi direct radiator, as shown in Fig. 7, is used to heat the room, and to supply a current of fresh air from the outside through the radiator into the room. Radiators of this class are supplied with regulating dampers to control the quantity of air admitted through them to the room. The indirect radiator, shown in Fig. 8, is always placed in a chamber in the basement beneath the room it is intended to heat. The chamber may be made of wood and be lined with tin, or it may be made entirely of galvanized iron or brick work. Air is brought from the outside to the lower portion of the chamber; it is then passed through the sections of the radiator to the upper part of the chamber, whence it is directed through pipes, or flues, to the room to be heated.

When the semi-direct or indirect radiators are used, some means of exhausting the foul air from the rooms must be provided, especially

FIG. 7. SEMI-DIRECT RADIATOR SYSTEM.

inlets are of advantage, it is found that one outlet gives better results than a larger number.

The indirect method of heating is generally resorted to for the purpose of keeping the radiator out of the room, either because there is no room for it, or because its appearance is objectionable, but it is also resorted to for purposes of ventilation only. In residence work it is nearly always put in as shown in Fig. 8, but, when used for ventilating purposes mainly, it is put in as shown in Fig. 10 in which the arrangement of an indirect radiator system is given in connection with a special ventilating flue. For in the case of the indirect; as the heating of the room depends entirely on the circulation of the air through the radiator. In ordinary residences the fireplace chimney will be sufficient for this purpose, but in larger buildings special flues should be provided. The semi-direct radiator is very much used for schools and hospitals, or similar buildings where large quantities of fresh air are needed for ventilation. This system has the advantage of being able to supply fresh air at as many points in the rooms as there are radiators Figure 9 shows a room containing six semi-indirect radiators, while the air exhausted at one foul-air register. The supply of fresh air at six different points makes it almost certain that the air in the room will be constantly changed, without creating drafts at any point. While a number of

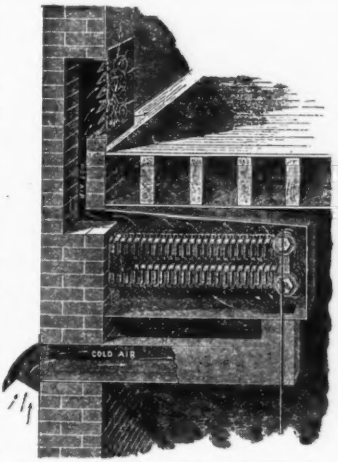


FIG. 8. INDIRECT RADIATOR SYSTEM.

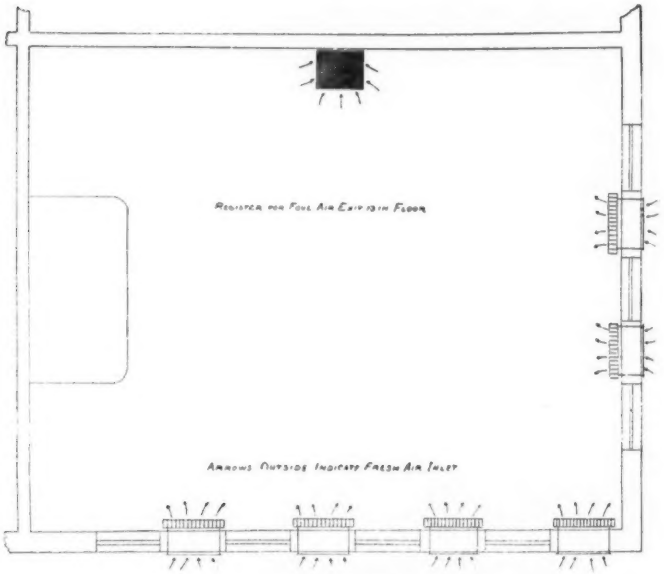


FIG. 9. ROOM WITH SEMI-DIRECT RADIATION.

such uses radiators are made with sections at greater intervals to admit of a rapid circulation of air through them. The chamber used for this work is much larger, and is supplied with a mixing damper, so that the air can be tempered without the quantity being diminished. In all cases where this method is adopted it is well to place the register in the wall, on the inside of the room, about eight or nine feet from the floor, and the air should be projected towards the cold side of the room, as shown in Fig. 10. The foul air should be taken out at the floor on the side of the room where the air is brought in. The circulation will then be about as indicated by the darts in Fig. 10. With this method of ventilation, and with the gravity system of steam heating, it is common to get a change of air in large rooms from six to ten times per hour.

A very important matter in steam heating is the removal of the air from the radiators, as the steam rises up to supply them with heat. To effect this purpose air-valves are used, and, though an ordinary air-cock will answer for the purpose, the valves generally used work automatically,—*i. e.*, they open when cold, and close by expansion when heated. Various patterns of these articles are sold, but they

may be classed under two heads,—one kind closing by expansion only, either by a composition plug or metal strips, and the other, the float valves, closing by expansion when heated, but, when the radiator gets full of water, closing by the action of the float. By the use of automatic valves of a good pattern, the air leaves the radiator as the apparatus heats up, and again enters it when the steam cools down. It is just as important that air should be let in when the radiator cools, as it is to let it out when it heats up, for the reason that, if the radiator cools and no air is let in, a vacuum is formed, and the water is liable to be lifted out of the boiler.

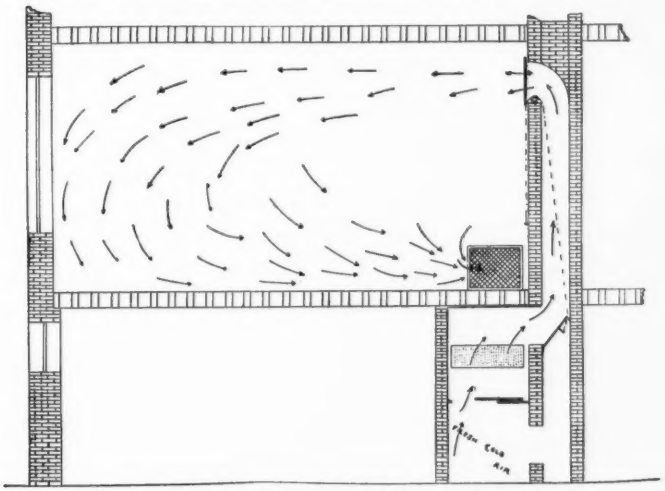


FIG. 10. ROOM WITH INDIRECT RADIATION.

Economy in the operation of a steam plant is effected very largely by the working of the air-valves. This is very marked in a large plant,—so marked that in some cases I have examined, when mechanical means had been resorted to for removing the air from the radiators, a saving of 25 per cent. in fuel resulted. Fig. 11 illustrates one type of plug-expansion valve, and Fig. 12 one of the float type.

A building loses heat through the windows, or glass surface, through the exposed walls, and by the changes of air in the rooms. One rule very widely used is based on the cubical contents, with an arbitrary allowance for more exposed rooms. It is as follows: One foot of radiation will heat 60 cubic feet of space in inside rooms with one exposure and the average windows; 50 cubic feet in rooms with two exposures and average windows; 40 in a room with three sides exposed

and windows on each side; and 40 in bath-rooms,—all for rooms in residences on the ground floor. For the second floor 10 per cent. less is needed, and for the third floor 20 per cent. less, the quantities for these floors being governed by the fact that the heat rises from the lower floors through the halls. If, however, these floors are not open, one to the other, they are treated as ground floors. For stores and such buildings it is usual to figure one foot of radiation to 60 or 70 cubic feet of space; and, with exposures only at the front and back, as in the case of stores in the middle of a block, one to 80 or 100 is sufficient. Another and more refined rule for ascertaining the required amount of surface is advocated by Prof. R. C. Carpenter, of Cornell University. "One quarter of the exposed wall surface in square feet, the square feet of glass exposure, and $\frac{1}{15}$ of the cubical contents,—this, divided by four, gives the amount of surface in square feet needed for the room." This involves a presumption that the air in the room is changed only once an hour, but, as a matter of fact, two or three changes per hour must be provided for. It is customary to allow, in halls in houses, for three changes, or $\frac{3}{15}$ of the cubical contents; for rooms on ground floor, $\frac{2}{15}$; and for rooms on the second, $\frac{1}{15}$. This rule seems to work very satisfactory, if applied with judgment. It must not be understood that it is arbitrary for all exposures, for it is customary to add 10 per cent. in the case of northerly or very exposed rooms, and to deduct in the case of those that are less exposed. If semi-direct radiation is used, it is customary to add 25 per cent. to the amount needed for direct, and, if indirect is used, 50 per cent. is added the proper number of air changes being provided.

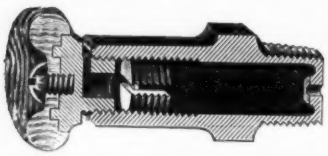


FIG. 11. PLUG EXPANSION AIR VALVE.

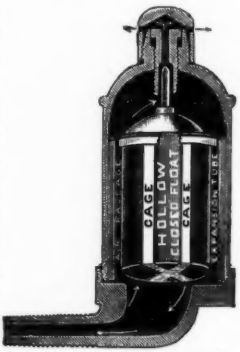


FIG. 12. FLOAT AIR VALVE.

The cost of erecting steam heating for residences by direct radiation averages from 1½ to 2½ cents per cubic foot of space heated, and for indirect from 2½ to 4 cents per foot of space heated. For schools heated and ventilated by the methods illustrated in Figs. 9 and 10 the cost is about $250 per room of the average size, seating fifty pupils, and in which the air is changed eight to ten times per hour.

MINING THE GOLD ORES OF THE WITWATERSRAND.

By H. H. Webb and Pope Yeatman.

IT is hardly possible, in a magazine article, to write in more than a cursory way on a subject so extended as "Mining on the Witwatersrand," the Rand being many times greater in area than any other gold-mining camp of the world. It is a field on which have been centered mining engineers of several nationalities, the largest percentage of whom are English and American, all "digging out" the same problems under the same conditions,—with few local variations,—bringing to their aid different methods of thought and training, yet all confined within one broad channel of operation and a more or less established method of procedure.

The Witwatersrand proper may be said to extend from Boksburg on the east to beyond Krugersdorp on the west with the city of Johannesburg as a center—a distance of some forty miles. If the offshoots, Heidelberg on the east and Klerksdorp on the west, be added, the total length of the mining reefs will approximate one hundred miles. For the greater part of the central section, one may drive mile after mile along what might be called an avenue of the largest gold-mining properties in the world, comprising both outcrop and deep-level companies.

A more tangible conception of the magnitude of the industry may be gathered from a consideration of the following table, giving the gold output, according to the State mining engineer's returns, for the years 1895 and 1896, and up to the end of September, 1897. It will be noticed that the output has been progressive, that of 1896 being a little higher than that of 1895, while that of 1897, taking into account the approaching advent of several additional companies as producers, should reach, or even exceed, 3,000,000 ounces.

GOLD OUTPUT.

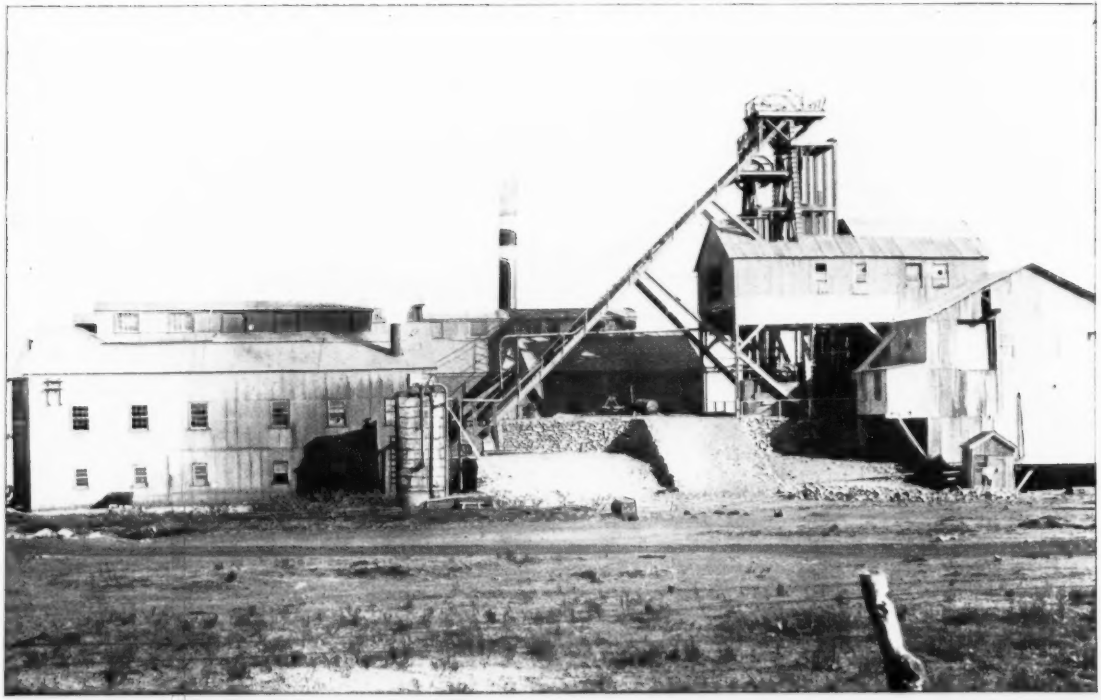
Year.	Tonnage Tons of 2,000 lbs.	Total yield.	Total value.	Av. yield per ton bullion.
		oz. dwts.		
1895.	3,456,575	2,277,640–4	£7,840,779	13.2 dwts.
1896.	4,011,707	2,280,892–4	£7,865,341	11.3 "
To Sep. 1897.	3,789,776	2,152,664–0	£7,496,479	11.3 "

The first row of deep levels, which are gradually swinging into line as producers, and which have tapped the reefs at depths varying from 500 to 1,500 feet, will ere long have to transfer their name of "Deeps" to the second row, whose depths will vary from 1,800 to 3,000 feet, and on some of which sinking is in active progress at present. Deep workings will undoubtedly extend to the third row, with depths of shafts from 4,000 to 6,000 feet, and probably beyond that. The factors to be considered—heat, water, and mechanical appliances—will not prove insurmountable difficulties. At the Robinson Deep, where the No. 1, or eastern, shaft has reached a depth of 2,450 feet, the difference in temperature between the surface and the lowest workings is 11 degrees, or a rise of 1° F. every 200 feet,—this, too, in a shaft which at present has no underground connection with its brother shaft, No. 2, or with the surface. Such a variation can hardly be considered as denoting a ratio prohibitive of working at double the depth. The degree of variation was ascertained by sealing a recording thermometer in drill holes, and allowing it to remain for a considerable time ; the figures have been verified by similar experiments in other deep shafts. Where there is artificial ventilation, the temperature in the working places may be expected to be lower.

In the matter of water, the Witwatersrand may be considered fortunate. Again citing the Robinson Deep, the deepest mine at present on the Rand, the use of pumps, except near the surface, has so far been found unnecessary, the slight amount of water encountered being handled easily by bailing in the ordinary course of hoisting the regular loads with skips. In the two shafts the water does not exceed fifty gallons per minute, three-fifths of which is taken up at a depth not greater than two hundred and fifty feet. This may be local, but the general experience on the Rand tends to show that the greatest amount of water is found at depths comparatively near the surface. There are exceptions to this, and cases may be cited where water has proved troublesome, but even these, in the small amount of water they have had to handle, will compare most favourably with many other mining districts.

In the matter of mechanical appliances, the Rand, with the rest of the world, is progressing. The cosmopolitan character of its mining inhabitants stimulates to an energy and rivalry unusual in other mining centers. In hoisting, the Rand can do what has been done elsewhere,—as at the copper mines of Lake Superior, where shafts have already been sunk to depths of about 5,000 feet.

One might subdivide the mines of the Witwatersrand into outcrop and deep levels, but this distinction, while strongly marked at



VERTICAL SHAFT, LANGLAAGTE ROYAL GOLD-MINING COMPANY.

HEADGEAR OF INCLINE SHAFT, KNIGHTS GOLD-MINING COMPANY, WITWATERSRAND.

present, will, in a few years, become nominal. The outcrops have passed through the initiatory stages of prospect work and cheap equipment,—of feeling their way, as it were,—and now, in consequence of the work done by them and the first row of deeps, confidence may be said to have been established for future depths.

Equipment. The modern equipment of an outcrop property may he said to differ but slightly, and only in detail, from that of a deep level. The old and substantial "stand-by," the Cornish pump, holds its own for moderate depths of, say, 1,000 to 1,200 feet, and is characteristic in the outcrop equipment, the average size being about 8 inches with a stroke of 5 or 6 feet and lifting from 250 to 375 feet. For the deeps, the electric, or some other, air pump will take its place. At the Knights Deep three-throw electric pumps of the three-phase system have been installed in the shafts, with lifts of 500 feet. The Rand Mines, Limited, are prepared to use Reidler differential air pumps, with 1,200 feet lift. With the deeps the head gear and winding engines are necessarily heavier. Underground the workings are much the same,—development, haulage, and stoping differing not at all, or but slightly. A description of one will serve for the whole, save in a few details, and the problems to be solved are as much those of economic management as of mining and engineering skill.

Shaft-sinking, with few exceptions, has been done by native hand labour, the rate of progress in a well-started shaft being from 60 to 164 feet per month, 156 feet being done in the west shaft of the Simmer & Jack East for the month of July and 164 feet in the west shaft of the Angelo Deep for the month of August, the former in quartzite and the latter in slate. This rapid rate of sinking could not have been much exceeded by machine drills, for the time lost in sinking is spent in removing the dirt from each succeeding blast, which must be done by hand labour and occupies at least one-half or five-eighths of the whole time. For this work the highest wages paid to natives is 2s. 6d. per shift; whites receive about £1 per shift, with the incentive of a bonus per foot for sinking in excess of a certain amount per month. The average rate of sinking for the first nine months of 1897, in two deep shafts in which rapid work has been done, was a trifle over 100 feet per month, and the cost per foot, including white labour, native labour, compound expenses, timber, explosives, lubricants, miscellaneous stores, fuel, maintenance, and engineering fees, was £21 19s. 7d.

The cost of sinking inclined shafts has been less, for the reason that, when the necessary points were reached, levels were started and driven, and the burden of the general operating expenses was thus

distributed, not only over shaft-sinking, but over drifting and general development as well, whereas in the case of vertical shafts no distribution of expenses could be made until the reefs were reached.

The shafts on the outcrops have generally been of three compartments,—two for hoisting and one for pumping and ladder way. On the first row of deeps the shafts have usually four compartments,—one for pumping, one for men, and two for hoisting; on the second row of deeps the tendency is to five compartments.

In a few vertical shafts cages are used, but self-dumping skips of from 1 to 3½ tons' capacity are the rule, and during sinking operations, in many of the shafts, buckets are employed, better progress, as a rule, being made in sinking with them, as the timbering can be kept sufficiently far above the bottom of the shafts to prevent injury when blasting, and the time lost in removing the blast can be lessened by the continuous loading possible where there is always a bucket at the bottom. While flat ropes are used in some cases, the round rope is the most common. Of course, on incline shafts the flat rope is impracticable.

In the first row of deeps it is the practice, on cutting the reefs, to turn off on the underlay, and continue the shaft-sinking on the incline. In very deep shafts an electric or air hoist will probably be placed in the station at the head of the incline, and all ore below that point hoisted to the station in skips and dumped into pockets, or bins, leading into the vertical shafts, from which skips will be loaded and hoisted direct to the surface.

Electric hoists of 300 k. w. are being installed in the main stations of the two shafts of the Robinson Deep, and will be used for working all the property below that point, receiving the loads at the various stations on the incline and hoisting to the bins at the main station, from which skips in the vertical shafts will deliver the ore to the surface. From the inclines levels are driven at distances varying between 100 and 200 feet, depending on the dip of the reefs, and the rapidity with which it is desired to open up ground for milling. At each of these levels it is customary to put in pockets connecting with the incline.

Shaft Timbering. There being no native timber of suitable quality, Oregon pine is generally used. At one time Australian Karri wood was introduced, but, owing to its high first cost, expense of framing, and weight, it has been abandoned. It is probably a very durable wood, and was used in order to lessen the cost of shaft repairs, which in a highway of great traffic is an item to be considered.

The shaft timbers consist of the usual wall plates, end plates, dividers, and studdles, well wedged, with bearers every 50 to 100 feet

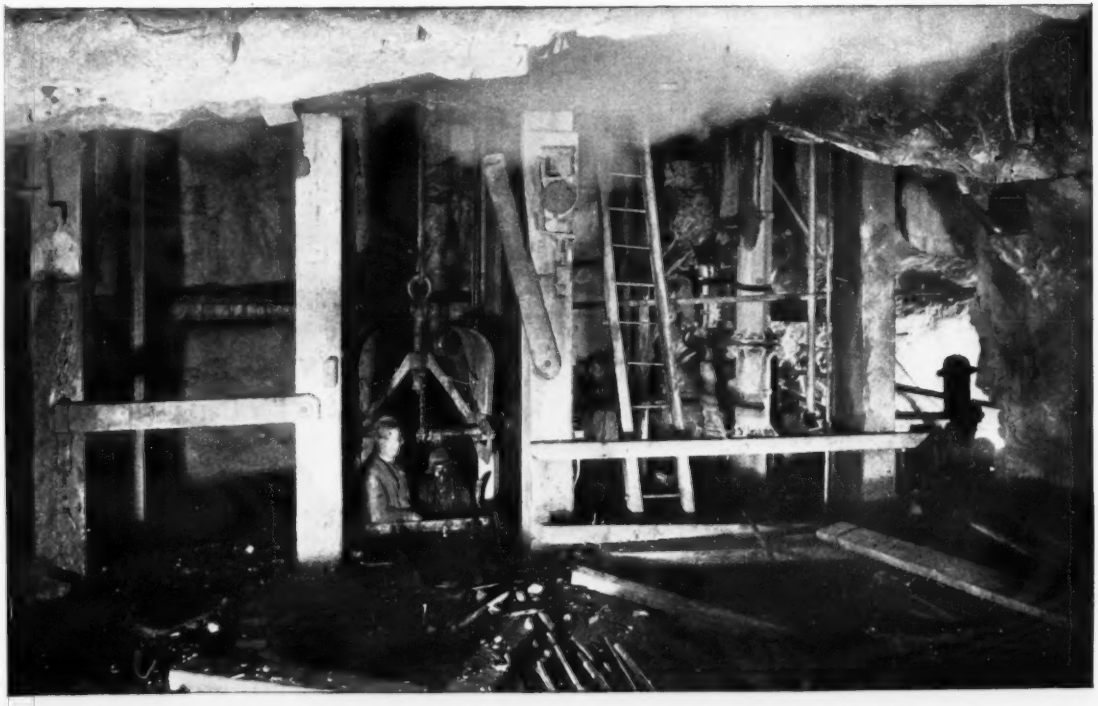
TIPPLERS AT NORTH VERTICAL SHAFT, SIMMER & JACK PROPRIETARY MINES, WITWATERSRAND.

resting in hitches cut in the rock. For Oregon pine the wall and end plates are 8 × 8 or 8 × 10, studdles 8 × 6 or 8 × 8, dividers 6 × 8, end bearers 10 × 12, intermediate bearers 6 × 12, and guides 5 × 4.

The cost of timbering a five-compartment shaft averages from £3 5s. to £3 10s. per foot. Lagging is but little used, save near the surface, or at occasional spots where loose ground is encountered; it generally consists of 3 × 9 deals.

Development. In opening up a mine the following plan is usually pursued. Drives are driven on the reef, east and west. In some cases, where payable reefs are close together, one main drive is sufficient, but in most instances it is necessary to crosscut to the second reef, and run another main drive along that. From the main drive, at distances of between 200 and 400 feet or more, upraises are driven to connect with the level above, and winzes sunk to the level below. At distances of about 40 feet boxholes for receiving ore from the stopes are put in.

The work of development is generally done with machine drills. Were it a question of individual ownership of the several mines, and were time no object, native hand labour would undoubtedly be cheaper, but in opening up a property, say, a deep for 120 to 200 stamps, or in keeping a large outcrop mill running and development well ahead, with perhaps an impatient body of shareholders in England or elsewhere, time is of importance, and the air drill serves the purpose in a superior degree, besides supplying ventilation. In a new property, interest on the money to be invested is to be considered, and quick time in reaching the producing stage is of great importance. In an old property—a steady producer, with a fair amount of development ahead—hand labour can be used to advantage. The drills most in use are the Ingersoll-Sergeant and the Rand-Slugger. The rates of progress vary. In single drives, where one machine is used, from 60 to 100 feet are driven per month; in double drives, where two drills are operating, from 90 to 120 feet. The work is generally let by contract at from £2 to £2 10s. per foot for single drives and £3 to £3 10s. per foot for double drives, the contractor supplying labour, candles, and explosives, and the company supplying drills, air, maintenance, etc. Lower rates prevail when the contractor is provided with at least two faces to work, for then no time in drilling is lost while the dirt from each blast is being removed. With native labour the rate of progress would be from 30 to 50 feet per month, and the cost per foot from one-half to two-thirds that of machine work, with no air or maintenance to be supplied, but with ventilation poor. Timbering has seldom been necessary in the driving of levels, or, in fact, in any of the underground work.



STATION AT HEAD OF INCLINE, NO. 1 SHAFT, SIMMER & JACK PROPRIETARY MINES.

Tramming the ore from the faces or from the boxholes is usually done by boys. The trucks employed have a capacity of about 16 cubic feet. The gauge is 18 inches, and the weight of the rails varies from 12 to 16 pounds per yard. Tramming and loading in drives, when done by contract, costs from 5d. to 6d. per load of 1,800 pounds.

Stoping. Stoping is done both by hand labour and by machines. So far hand labour has been much the cheaper, and machines have been resorted to only when native labour was scarce. By the employment of smaller machine drills, and allowing one white man, with the aid of natives, to run two or more drills, it is possible to make the cost of hand and machine labour approach each other. The employment of small drills will reduce the excessive amount of dynamite used per ton of rock broken, the cost of labour by the substitution in part of native labour for white, and probably the cost of power, steel, etc. Another great advantage which will result from this modification will be the reduction of the number of natives required,—an important consideration in view of the scarcity of natives at certain seasons.

The smaller drills, compared with the larger ones, are easier to handle, require less air to operate, drill smaller holes, and can be used in narrower stopes. With the large drills a stope of from 5 to 6 feet is necessary, while with a small drill one of 36 to 40 inches can be mined. On narrow reefs a small stope should be mined, as otherwise too much barren ground, of which only a small percentage can be sorted, will be broken down, and so the grade of the ore will be reduced.

Where stoping is done by hand, underhand stoping is the rule, as Kaffirs, not being skilled miners, do much better work in underhand than in back stoping. In opening up a stope by hand, the work is started on both sides at the top of an upraise, and gradually widened and carried on to the bottom. Where machines are used, underhand stoping, back stoping, or breast stoping may be employed.

In developing quickly, the method of back stoping is often used, a back drive being driven on the reef above the main drive, leaving a pillar of 8 to 10 feet between, and on the former the stopes are started. The rock is blasted towards the boxholes, so as to diminish shovelling as much as possible. The pillars can afterwards be robbed. Drives are either protected by leaving a strip of the reef, as before indicated, or by putting in stulls and lagging.

Including shovelling, the average cost of stoping 12,000 tons for the month of September at the Simmer & Jack Proprietary Mines, Limited, was 6.8 shillings per ton milled, including all supplies,

STOPE, 4TH LEVEL EAST, EAST INCLINE SHAFT, SIMMER & JACK PROPRIETARY MINES.

SORTING AND CRUSHING STATION, NO. 2 SHAFT, ROBINSON DEEP MINING COMPANY.

labour, office expenses, management, insurance, etc. The cost of shovelling was about 1 s. per ton milled.

When the reef has a dip of 40° or more, the expense of shovelling is not so great, but below 30° the cost becomes considerable. When the reefs are flat, it is possible to run trucks into the stopes, and load them there.

For holding up the roof, stulls are sometimes put in, or pillars left. Very few supports are required, the backs being strong. In carrying on stoping with Kaffirs, one white miner has charge of one or more stopes, and looks after from ten to thirty boys. The miner tells the Kaffirs where to drill the holes, and attends to the loading and firing. A day's work for a drill boy is three feet, and the wages received are from 1s. 6d. to 1s. 8d.

Dykes and faults cause more or less trouble in mining on the Rand, but the main cross faults are becoming better known and are being carefully mapped. We may still look for trouble from faults and dykes parallel to the strike of the reef in the deep levels, but, while these dyke faults make dead work necessary, they usually effect an upthrow of the reef on the south side, bringing the reefs nearer the surface, and in some cases form an overlap, thus giving a gain of ore instead of a loss.

Ventilation. Ventilation is usually effected by natural draught, by means of two or more shafts, and from level to level through upraises. Artificial ventilation is often resorted to, especially in the developing mines, by means of blowing engines, or fans, operating sometimes on the vacuum, and sometimes on the plenum, method.

Sorting. There are few mines on the Rand where sorting in some form is not practised, at first roughly in the stopes, where the larger lumps of waste are picked out and thrown aside for filling, and again on the surface, aided generally by mechanical appliances. Surface sorting is done either at the headgears or at a central station, the latter practice being introduced almost entirely at the properties of the Rand Mines, Limited. The appliances are generally travelling belts, from 30 to 50 feet in length, or circular rotating tables about 30 feet in diameter. At some of the mines the sorting is done on floors. The ore is at first dumped over grizzleys inclined at angles of from 40° to 50° and set at 1½ inches or more, according to the degree of fineness desired in the sorting. The material too coarse to pass through the bars slides on to the travelling belt, the rotating table, or the floor, as the case may be, where it is wet with a hose; as the belt or table moves, natives on either side pick out and throw into waste-bins the worthless quartzite, etc., the banket remaining being dumped into crushers of the Gates or Blake pattern set to three

inches or under, and going thence to the mill. Where sorting is done on the floor, the waste is picked out by natives, and the remaining banket is shovelled into the ore bins. At some mines, where the reefs are narrow, double sorting on round tables is being introduced. The ore is dumped from the skips, passing over two sets of grizzleys producing three sizes of material, the first or finest going direct to the mill, the middlings being sent to the second table, and the coarse material being delivered on a rotating table for the first sorting, going thence

MECHANICAL HAULAGE BY ENDLESS TRAVELLING WIRE ROPES.

through crushers and over grizzleys to a second table for the second sorting, and again through crushers and to the mill.

The amount sorted out in a single operation varies, and, on an average, is probably from 12 to 16 per cent., though at the Ferreira the figure has sometimes risen to 40 per cent. on floors alone.

The percentage varies with different mines, according to the width of reefs and absence or presence of well-defined walls. The amount of fines made in the stopes is an important factor, and the use of machine drills materially lessens the percentage which can be sorted out by producing more fines in blasting.

MINE LOCOMOTIVE, SIMMER & JACK PROPRIETARY MINES.

WOODEN HEADGEAR, KNIGHTS DEEP GOLD-MINING COMPANY, LTD.

The costs of sorting and crushing with sorting tables and travelling belts vary from 5½d. to 1s. or more per ton milled, depending on the amount sorted out. Maintenance in some of the older styles of belt is higher than with round tables. With revolving tables, crushing and sorting at the Geldenhuis Deep has averaged about 5.58d. per ton milled. With sorting on floors, where as much as

35½ per cent. of waste has been picked out, the cost of sorting alone has amounted to 10d. per ton of ore milled. At the Meyer & Charlton, on travelling belts, the cost per ton milled, for sorting and crushing, has been 5.54d.

Surface tramming is done by natives, mules, endless-rope haulage, in two or three cases by electric tram lines, and at the Simmer & Jack new plant by a thoroughly-equipped steam railway.

Headgears are generally of wood, and vary in height from 40 to 90 feet. A few steel relics of the early days, when all transport was

STEEL HEADGEAR, ROBINSON DEEP GOLD-MINING COMPANY.

AIR DRILLS ON INCLINE, NO. 1 SHAFT, SIMMER & JACK PROPRIETARY MINES.

from Kimberley by oxen, and wood was scarce, are still in use. Modern steel headgears, 85 feet in height, have been recently placed at both shafts of the Robinson Deep, but the present tendency is to wood, the cheaper first cost and ever more plentiful supply of large timber favouring this.

Where ore breaking and sorting are done at the shafts, the headgears are equipped with crushers, sorting appliances, ore bins, etc., making the cost considerably more than when they are used simply for hoisting.

Winding engines on the outcrops are of the double-cylinder geared type, but for nearly all the deep shafts direct-acting engines, of varying sizes, are being used. For the Simmer & Jack East compound-condensing winding engines have been ordered.

Boilers. According to the government report for 1896, there were 1,101 boilers on the gold mines of the Witwatersrand, with a heating surface of 809,743 square feet. These are of all types, and include locomotive, vertical, Lancashire, Cornish, etc. The horizontal multitubular, Babcock & Wilcox, and Heine are most favoured in the recent equipments. In an efficient plant the consumption of coal per i. h. p. is about 5 pounds, and the water evaporated is 6 to 7 pounds per pound of coal.

Compressors. The Ingersoll-Sergeant, Walker & Son, and Reidler are the ones most favoured in the more modern instalments. They are compound steam and air, and condensing, of from 20 to 30 drills' capacity at this altitude. There are other varieties, as the Rand, Yates & Thom, and Allis, of all capacities, with several of the vertical type.

At a recent meeting of the Society of Engineers and Architects, in Johannesburg, the following data as to cost of running air drills were presented by Mr. L. I. Seymour.

A King-Reidler compressor running thirty or thirty one 3¼-inch Ingersoll-Sergeant drills, and from one to five air-driven pumps, for three months, showed an average of less than 9 actual h. p. per drill, exerted continuously by the compressor.

The average depth of hole drilled per shift was from 20 to 24 feet. The total cost per drill per month was £119 14s. 9d., distributed over cost of coal, stores, repairs, spare parts, repairs to compressor and boilers, labour (white and black), sharpening bits and cost of steel, interest on plant, and redemption at 12 per cent. of original cost.

At every mine on the Rand provision is made for more or less lighting by electricity, and in many instances an installation for some power, such as pumps, haulage, and various isolated small motors.

At Brakpan, adjacent to the coal mines, the Rand Central Electric Works have been established, for the purpose of selling power to the various mines along the line of reefs. The current is three-phase, of low tension, and is raised by transformers to 10,000 volts.

For supplying electric power to several of the deep mines of the Consolidated Gold Fields of South Africa, Limited, a plant is under erection on the three-phase system, three 500-k.w. generators being at present installed.

Coal is abundant, and is in close proximity to the mines, to which good fortune the gold-mining industry is greatly indebted for its success. The seams lie near the surface, and are generally of unusual thickness, and can be cheaply mined. The quality is somewhat inferior, having a high percentage of ash. According to the State mining engineer's report, 863,811 tons were consumed in 1896 at an average cost of 19s. 1d. per ton, freight being about 3½d. per ton per mile. With few exceptions, coal is delivered to the mines in bags of about 200 pounds capacity. The cost of coal is between 7 and 9 per cent. of total working costs.

This review of the mechanical features of the equipment and operators will be supplemented, in the succeeding number of the Magazine, by a discussion of the conditions of labour, supplies, and economic features of mining on the Rand.

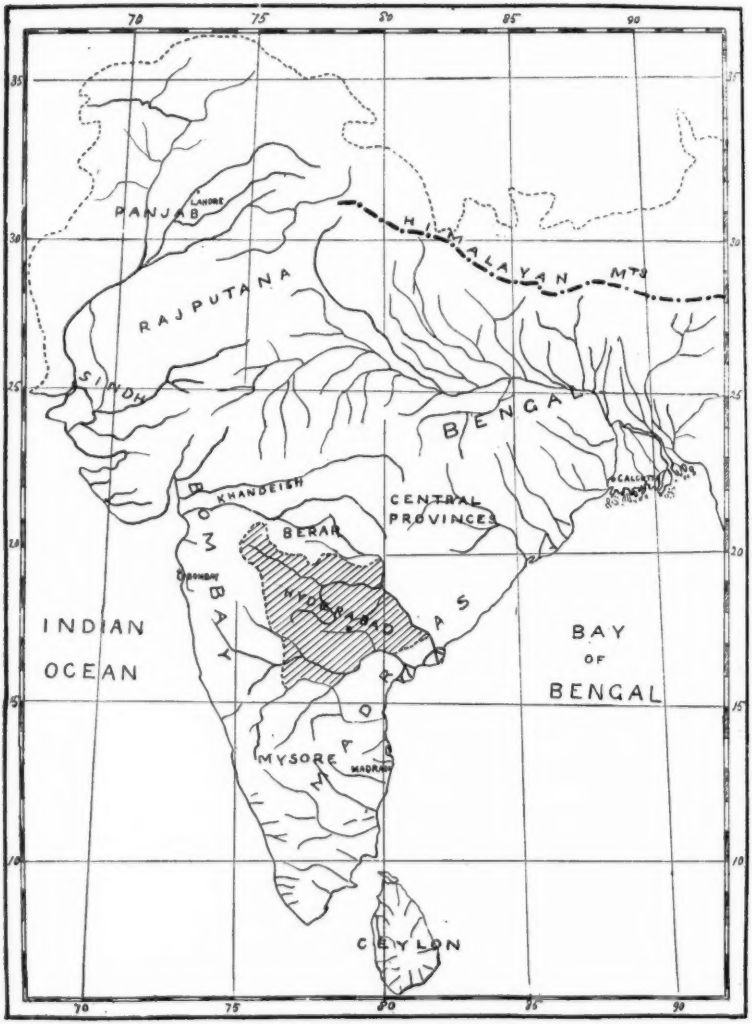
TANK IRRIGATION IN CENTRAL INDIA.

By G. Palmer.

THE State of Hyderabad (or the Nizam's Dominions) lies between 15° and 20½° north latitude and 74½° and 81½° east longitude; see map (Fig. 1). It covers an area of 82,698 square miles, or about one-twentieth of the area of India subject to British rule or influence. The western boundary of the State runs parallel with the western Ghauts, and lies at levels of about 2,000 feet above the sea at the northern extremity and about 1,400 feet at the southern. The country may be considered as a fairly level table-land for three-quarters of its width from west to east, sloping afterwards somewhat rapidly to a level of about two hundred feet in the valleys of the Godavery and Kistna rivers. Along the western boundary, and for about half the width of the State, the country is open and undulating. The broad valley of the Godavery is deep in alluvial soil, and the land is productive in dry crops. The hills in the north-west, which rise to 2,500, and in some instances to more than 3,000, feet, are basaltic; they fall abruptly into the plains of Khandeish and Berar on the north. Over the eastern half of the State are ranges of gneissic formation, attaining heights of from 200 to 500 feet, and occasionally reaching 1,000 feet above the ordinary level of the land. Time and the process of weathering have disintegrated the gneiss, which may be seen in every stage of the process, from huge piles of boulders, in appearance as if heaped up by primeval giants, to gravel, or moorum, and ultimately to red earthy soil, fertile and well suited for wet cultivation. A band of limestone, belonging to what is known as the Kurnul Series, runs east and west, some fifty miles wide, across the western half of the State,—a hard, laminated stone, extremely useful for building purposes. Iron stone hills and coal-measures exist on the eastern side of the State, bordering the Godavery.

Roughly speaking, in the western half of the country black cotton soil chiefly prevails, the result of the disintegration of basaltic rocks. In this soil successful cultivation depends only on the rain that soaks into it in the monsoon season; the crops are cereals, cotton, grain, castor, linseed, and other oil plants. These are called dry crops. In the eastern half of the country the red earth, the result of the disintegration of gneiss, is most suitable for the cultivation of rice and sugar cane, which are essentially wet crops.

The capital of the State, the city of Hyderabad, is situated about



MAP OF INDIA.

The shaded portion represents the Hyderabad State.

FIG. 1.

midway between the eastern and western boundaries and one-third way from the south between the southern and northern. The dotted line shown on the map (Fig. 2) divides the country where wet cultivation abounds from that in which dry cultivation is mostly practised. It is not to be supposed that there are no irrigated crops on the western side of that line, but, as we proceed west and north, we find that irrigation works get rapidly fewer, and disappear as we approach the boundaries. Irrigation on a small scale, by the water supplied from

FIG. 2. MAP OF THE HYDERABAD STATE.
The irrigation district lies to the east of the dotted line. Round dots indicate rain gauges.

wells, exists everywhere, but this is confined to small patches, and, with the exception of an occasional acre or so of sugar cane, to little more than garden produce.

The two principal rivers are the Godavery and the Kistna, both rising in the western Ghauts and flowing eastward into the gulf of Bengal. The Godavery has several large tributaries, among them the Sivenna, the Manjera, and the Manair, all of which drain extensive

tracts of country, the main river below Sironcha forming the boundary between the Hyderabad State and the central provinces. The chief tributaries of the Kistna are the Bheema and the Toongabudra. The former rises in the Ghauts, to the east of Bombay, and the latter has its source some 350 miles further south. They both join the Kistna in the south-west corner of the State. The Toongabudra and the Kistna form the southern boundary of the State for nearly 400 miles. The Godavery and its tributaries drain some 45,000 square miles of country, and the Toongabudra and Kistna 4,500 and 19,000 square miles respectively. Enormous volumes of water, therefore, are carried off by these rivers during the rainy season, and their extreme importance in regard to irrigation works on a large scale is at once apparent.

To describe to how small an extent they have as yet been used in this connection, so far at least as the Hyderabad State is concerned, and to how great an extent they might be so used, would unduly swell the limits of this article. The whole area of the Hyderabad State is divided, for purposes of administration, into eighteen districts, or "Zillahs," which are grouped in four divisions, or "Subas." These divisions are the central and northern, called the Bidar division; the eastern, or Warangal; the western, or Aurungabad; and the southern, or Gulburgah. The average size of a district is 4,600 square miles, or a little more than three times the average size of a county in Great Britain, and that of a division is more than 20,000 square miles. The administration is conducted on lines similar to those prevailing in British India. A taluqdar governs a district, and a subadar a division; these are responsible, through secretaries of departments, to the prime minister, who, aided by a cabinet council, is answerable to H. H. the Nizam, the ruler of the country. The boundaries of divisions are roughly shown in the map (Fig. 2).

As in British India, the principal revenue is derived from the land. Certain areas of land are crown-lands, or the private property of the ruler of the State; certain others are held by noblemen and gentry of the country, under grants made to them by former rulers. The area of all these may amount to one-fifth of the total area, and the government is considered to be the owner of the rest. It is let out to the cultivators at rates, per acre per annum, proportionate to the productive value of the soil.

In districts where irrigation is practised the government provides and maintains the necessary works, and of course levies a heavier assessment, that for wet—*i. e.*, irrigated—crops being, on the average, nearly nine times that for dry crops.

Until within the last thirty years the assessment was somewhat

irregular, and fluctuated with the needs of government, the favourableness of the seasons, or the zeal of the local collectors, and the revenues of much of the land were even farmed out to contractors; but in recent years the example of British India has been followed, the cultivated and cultivable areas have been accurately surveyed, and each field has been carefully assessed. The assessment holds good for thirty years, when it is liable to revision. The cultivator has now a sure knowledge of the amount of rent he will have to pay, and knows also that he will be the chief participator in the benefits of a good season. On the other hand, of course, the brunt of a bad season falls upon him, but here a paternal government comes to his aid, and, when a scarcity of rain prevents his raising sufficient crops even to pay his small rent, it remits a part, or even the whole, or allows it to stand in abeyance. Also, when worst comes to worst and famine prevails in the land, relief-works are started for those whose customary occupations are at a standstill, and every possible measure is taken to mitigate the horrors of scarcity and starvation. In the famine of 1876 77 the loss in government revenue amounted to R7,000,000, and this at a time when the total revenue did not exceed two-thirds of what it is at the present day.

Hyderabad, like the rest of the centre and south of India, depends for its prosperity on the south-west monsoon. This, setting in in Ceylon soon after the middle of May, works its way up the west coast, and, overcoming, as it gains its full strength, the barrier of the western Ghauts, advances steadily across the Deccan. Its normal date for reaching the Hyderabad State is June 5. It continues, with the wind prevailing from the south-west, till beyond the middle of September, when the wind, gradually veering round by west and north to the north-east, brings what appears to be a return monsoon, but what probably is the current of the south-west monsoon, which, passing, from the commencement of the rains in June, up the east coast and thence to the north-west up the Gangetic valley, has attained greater strength than that which is then exercised by the waning west coast current, and makes itself felt in the central provinces and the south. To this return current Hyderabad is often indebted for heavy falls that save the country from the scarcity that might follow a lack of strength in the original south-west current. The real north-east monsoon, so favorable to the Madras presidency, does not set in till a later date,—the end of October. It occasionally brings rain, and sometimes heavy rain, to Hyderabad, but is not to be relied upon. In November, 1896, however, after a very poor south-west monsoon, scarcity and distress, which had begun to be felt in Hyderabad, were much mitigated, and the outbreak of real

RAINFALL. (Inches and hundredths.)

Divisions.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	Average per year.
Hyderabad (city and suburbs.)	19.10	32.98	47.44	39.71	31.04	27.15	37.94	30.83	32.62	35.73	34.45	28.38	18.46	39.17	34.87	17.59	51.18	32.86
Northern	21.45	28.49	44.88	32.35	32.81	30.44	35.01	55.85	44.11	41.23	53.26	31.49	28.58	38.81	39.03	28.13	53.81	37.63
Eastern	15.55	25.76	42.17	32.52	27.23	22.78	29.98	35.87	30.07	29.92	37.39	25.86	25.15	35.77	28.87	23.80	46.12	30.28
Southern	11.25	28.34	40.99	29.50	30.84	25.46	29.35	34.34	23.00	31.95	37.36	30.81	23.84	31.36	31.59	16.31	45.21	29.50
Western	20.70	19.62	39.44	35.63	32.37	28.54	37.75	46.40	34.31	27.24	39.72	36.06	28.17	41.54	36.35	36.84	49.42	34.72

FIG. 3. TABLE OF RAIN-GAUGE RECORDS FROM HYDERABAD STATIONS.

famine was probably prevented, by the timely fall, during one week, of about three inches of rain, extending pretty generally over the whole State. As a rule, after the beginning of November very little rain falls in Hyderabad, till June again brings the south-west monsoon. A few light showers may occur about Christmas time, and the intense dry heat of March, April, and May may be relieved once or twice by slight falls; but these do little more than temporarily improve the precarious pasturage for village sheep and goats, and in the towns they but "bring out the smells," and are of questionable benefit from a sanitary point of view.

The features of the rain-fall during the monsoon season are very varied, and naturally of great interest to those concerned in the welfare of the State. Rain-gauges are kept at the chief town of each district, and at the head-quarters of each "taluk," or sub division of a district. Thus about 126 gauges are distributed with fair uniformity over the State, giving to each gauge an average of about 650 square miles. The gauges whose records are most to be relied upon are those at the district chief-towns. These records are reliable from 1876, and the table (Fig. 3) gives the yearly results at the city of Hyderabad itself, and in the four divisions for the seventeen years from 1876 to 1892. The positions of the gauges are shown by round black dots in the map (Fig. 2) and, though in each year the rainfall may vary considerably among the districts composing a division, it may be assumed that practically the same meteorological conditions prevail over the whole of one division, and that the

general average applies pretty nearly to each of its districts. Space hardly permits the details of each district to be shown here, but it is well to give the averages over the seventeen years, in order to show, against local variations, the general uniformity of the rainfall over the

RAINFALL (inches and hundredths).

	Districts.	Average of 17 years from '76 to 1892.	Wet or dry cultivation prevailing.	Heaviest rainfall in a year.	Year.	Least rainfall in a year.	Year.
Northern Division.	Hyderabad	32.86	wet	51.18	1892	17.59	1891
	Bidar	42.64	dry	70.00	1883	21.37	1876
	Mehdak	35.57	wet	64.34	1892	21.45	1876
	Indur	39.01	wet	60.47	1886	25.43	1879
	Elgandal	33.37	wet	51.94	1886	17.98	1891
East'n "	Warangal	32.52	wet	45.26	1883	16.86	1881[1]
"	Nalgunda	27.04	wet	49.19	1892	14.24	1876[2]
"	Mahbubnagar	31.29	wet	55.40	1892	13.11	1876[3]
Southern "	Raichur	26.64	partly wet	50.02	1892	12.27	1881[4]
"	Lingsugur	25.42	dry	38.94	1878	5.45	1876[5]
"	Gulbarga	28.96	partly wet	43.63	1892	12.38	1876[6]
"	Nuldrug	36.99	dry	50.01	1886	14.06	1876[7]
Western "	Bhir	32.46	dry	51.45	1883	17.94	1876[8]
"	Aurangabad	32.61	dry	50.81	1882	18.37	1876
"	Parbhani	34.13	dry	51.19	1892	16.26	1877
"	Nander	39.67	partly wet	58.83	1891	13.65	1877

[1] Scarcity in 1876–77.
[2] ditto nearly amounting to famine and the same in 1891.
[3] ditto ditto scarcity in 1891.
[4] Famine in 1876–77. Scarcity in 1891.
[5] ditto ditto
[6] ditto ditto
[7] ditto
[8] ditto in parts.

Assuming a general average throughout the country of 33 inches, the averages per month should be, in the most favorable monsoons, as follows :

January	2 in.	May	1 in.	September	8 in.
February	2 "	June	5 "	October	2 "
March	2 "	July	6 "	November	1 "
April	2 "	August	8 "	December	1 "
					33

FIG. 4. AVERAGE RAINFALL FOR SEVENTEEN YEARS.

whole State, and that the rainfall above does not determine the nature of the cultivation (wet or dry) prevailing in each district. The table above (Fig. 4) gives this information.

It will be seen that the highest district average is that of Bidar in the northern division, a dry cultivation district ; the next that of Nandair in the western division, also a dry district ; then come Indur in the northern division, a wet cultivation district, and Nulding in the

southern division, a dry district. The lowest is Lingsugur, in the southern division, a dry district, whose average is only an inch below that of the neighbouring district of Raichur, a dry district, in which there is a slight sprinkling of irrigation works.

Irrigation works prevail chiefly in the districts of the northern and eastern divisions, are much less common in those of the southern division, and scarcely exist in the western.

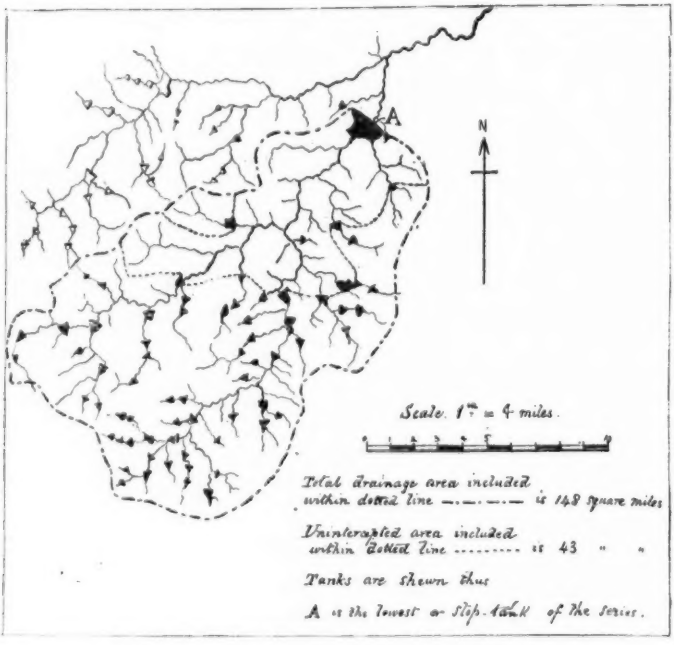

A
N
Scale 1" = 4 miles.
Total drainage area included within dotted line —.—.—.— is 148 square miles
Uninterrupted area included within dotted line ..... is 43 " "
Tanks are shewn thus
A is the lowest or Slip-tank of the series.

FIG. 5. A TYPICAL SYSTEM OF IRRIGATION TANKS.

The system of irrigation is mostly that known as the ancient Hindu system of tanks. The word "tank," in an Indian irrigation sense, means a storage reservoir. A tank has no definite size; its area of water-spread may be two or three acres, or it may extend to as many square miles; its depth may be 3 or 4 feet, or 100 feet, or more.

The word "Koonta" is used in Hyderabad to signify a very small tank, such as one of two or three acres only. The words "Sangor" and "Cherroo" are the Hindustani and Telugu equiva-

ents, respectively, of the word that has been coined into English as 'tank.''

Down every valley a stream must flow in the rainy season, its size depending upon the area of the ground that drains into it. A small stream is a feeder, or one of several feeders, to a larger stream, whose drainage area is the total of those of its small stream feeders. The larger stream is again but a feeder to one still larger, and so on till the great river is reached that carries the water from the whole accumulated drainage areas to the sea. In each little valley, in each larger valley, in each yet larger valley again, one or more tanks can be constructed, and thus the drainage area supplying a tank may vary from less than one square mile to one hundred square miles. It is not often that a tank has a drainage area of one hundred miles unintercepted,—that is to say, without numerous other tanks in the smaller valleys above it, which, if properly constructed and kept in repair, mitigate the rush of the large body of water that would otherwise flow directly into it. The danger to a large tank at the end of a series, when, by the breaking of the tanks above, the advantages of interception have been lost, may easily be conceived. In the Hyderabad State there are instances of tanks impounding water from very large areas, but space does not permit me to deal with them here.

The map (Fig. 5) shows a series of tanks covering an area of 148 square miles, and draining into a large stop-tank at the end. The area here illustrated embraces the upper branches of a large feeder of the river Moosey, which is itself an important feeder of the Kistna.

This series is typical of the system,—details of size, number, and arrangement of the tanks being, of course, subject to wide modification according to the topographical features and agricultural conditions of a district. The tank is the unit, the special consideration of which, in its engineering and economic aspects, is reserved for a succeeding article.

THE INTERPRETATION OF SANITARY WATER ANALYSES.

By Floyd Davis.

THE impurities that affect the quality of water for domestic purposes are inorganic and decomposing vegetable and animal matter and the micro-organisms of disease. Some of these exist in harmful quantities in the water of many streams, and in other sources that flow through, or originate in, rich agricultural or swampy land and densely-populated districts. A small amount of fine, non-silicious mud or silt in drinking-water is not known to produce disease, and is objectionable only from an æsthetic standpoint. But the large amount of angular particles of sand and decaying vegetation found in some streams is frequently productive of intestinal disturbances, like inflammation of the bowels, diarrhœa, and dysentery; and any water that is distinctly turbid should be regarded as non-potable, until it has been clarified and freed of its organic matter.

At certain seasons some algæ produce a disagreeable taste and odor that make it unpleasant to drink water containing them, while nearly all decaying vegetable matter favors the production of intermittent and malarial fevers. Malaria was once thought to be only of aerial origin, but the foremost investigators now attribute it also to stagnant water, containing an abundance of decaying vegetable matter. The celebrated case of the Argo, and the investigations made by Dr. Richard H. Lewis, of North Carolina, and others, show in many cases the water-origin of this disease; and malaria is liable to exist wherever the temperature is high, the vegetable growth large, and the country low and flat.

As people gain knowledge in sanitary science, many of these impure waters are abandoned in favor of deep wells, or they are mechanically purified, generally with the happiest results in reducing the number of fever cases, or in the entire eradication of the disease. While impure water is thus productive of malaria, the fever is not directly attributable to organic matter; it is produced by a protozoon, the *plasmodium malariæ of Laveran*, which is supposed to exist in and about impure surface waters, although the organism is rarely found outside the human body. Insects that inhabit swamps and stagnant ponds may also be instrumental in propagating this fever, since the common mosquito is now regarded as the host of the malarial germ, sometimes transferring it to persons susceptible to the disease.

Far more important and dangerous, however, than mineral and vegetable matter is animal refuse, such as sewage and drainage from cess-pools and privies. This not only furnishes a favorable pabulum for the growth and development of micro-organisms, but also opens an avenue to the system for admission of infection; and drinking-water contaminated with sewage is intimately connected with disease, as well as objectionable from an æsthetic standpoint. There is a vast difference, however, between the infectious nature of sewage in its fresh condition and that of sewage which has undergone complete chemical change. So long as it remains as sewage,—*i. e.*, retains its original nitrogenous ingredients not completely converted into new compounds,—it is liable to be disease-producing. Among the numerous bacteria of its earlier existence there are probably some that are harmful, and the sewage environment may so modify others as to render them pathogenic. But through the effects of dilution, precipitation, oxidation, and nitrification, these ingredients gradually disappear from contaminated water; still, we cannot rely on the disappearance of the most harmful agents at any given time, or under any given condition, for it is now well-known that the self-purification of water, so far as bacteria are concerned, is much less than was once supposed.

Still, under nature's agencies, polluted water may be so improved that the factor of danger becomes inappreciably small, and it may then be drunk with the same assurance of safety that prevails when we eat or breathe. Hence it will be seen that *pure* and *impure*, like *normal* and *abnormal*, waters are distinguished only by the amount of certain constituents common to all, and it is true that nearly all natural waters have some foreign substances which would condemn them, were they present in sufficient quantity. From the nature and effect of this extraneous matter, it is evident that a drinking-water should be considered *pure* only when practically free from decomposing vegetation, and absolutely free from fresh products of the human body. So sanitarians have learned that it is not so much the *quantity* as the *quality* of the impurities in water that determines its suitability for drinking, and the foremost investigators uniformly condemn all waters that are in the least contaminated with *fresh* sewage. Even after sewage has been changed by oxidation to its final products, there may be danger from the use of water containing it, on account of its germs. This is especially true with surface waters originating in a gravel and limestone soil, for the organic matter is changed to nitrates more rapidly than the bacteria are removed. And, as typhoid fever and cholera are well-known to be produced by infectious bacteria which accompany sewage, it is important, in interpreting

every sanitary water analysis, to keep in mind the changes through which sewage passes under the action of the constituents of the soil.

A water is pure and wholesome when it meets all the requirements of the body in absorption and elimination, even in the most delicate constitutions. But some waters have unpleasant taste from mineral and decaying organic constituents; some have unsightly appearance from color or suspended matter; some have disagreeable or disgusting odor; while others are so charged with inorganic salts that the kidneys are overworked in eliminating the waste products of the body. All these objectionable waters should be regarded as impure, and they are certainly unwholesome, because the system rebels against anything which is not approved by the senses of sight, taste, and smell. Such water is sometimes forced upon a community until public necessity compels it to be abandoned in favor of a pure and wholesome supply. We are safe in going still further, for, when a water is even liable to become contaminated with sewage, it should be guarded against with the same care that is exercised in dealing with the most dangerous poisons.

The diseases that are known to be produced by impure water are Asiatic cholera, typhoid fever, malaria, diarrhœa, dysentery, and some other intestinal disorders. These diseases are either the result of an irritant, or are produced by bacteria or other micro-organisms, and it seems at first thought that an investigation to determine the wholesomeness and suitability of water for domestic use should consist in searching for the immediate agents of disease. But experience shows that the bacteria in water are so numerous, and so resemble one another, that the harmful micro-organisms, even in the most contaminated waters, are but a small proportion of those that are present. Their determination requires the most careful study and patience, and much time, and the results are generally negative and unsatisfactory. So, in ascertaining the sanitary quality of a water, it is safer, as well as easier, to determine the organic impurities, like sewage, than the bacteria, for the pathogenic micro-organisms exist only in natural water that has, or once had, measurable quantities of organic matter. The amount of water required for a chemical and microscopical analysis is so large that any foreign matter which might exist in the general supply would, in all probability, also exist in the sample operated on; and the determination of sewage shows the possibility of accompanying dangerous micro-organisms. In sanitary water investigations it is not customary, therefore, to search for pathogenic germs, but to determine irritating substances and other associations and conditions that favor disease. This is done principally by chemical and microscopical analyses, and, in the testing of

filters, by additional bacteriological examinations of the water. But a thorough investigation of a public water-supply should always involve a sanitary survey of the surrounding country to determine the contaminating agencies. Sometimes also study of statistics will show a relation between death-rate and quality of water-supply; and in all this work much depends upon proper interpretation of the results.

The Sanitary Survey.

A sanitary survey will sometimes reveal enough pollution to condemn a water, no matter how small the amount of organic matter and how low the number of bacteria found in it. Whenever there are visible sources of filth, the water should not be used for drinking in its natural condition, especially when any of the pollution is sewage. Every season brings to our attention many cases of disease attributable to impure water, where the contamination is visible and might have been removed; and so the opinion grows stronger, year after year, that, by applying an ounce of prevention to the discovery and removal of pollution, pounds of cure would never be needed. It is always necessary to know the origin of a water that shows but little organic matter, before giving even a conditional final opinion of its quality for drinking, and the results should be compared with local standards of permissible impurity. The free ammonia sometimes found in deep wells would condemn a surface water without further study, and yet in the deep-seated water it is permissible; and the chlorine and nitrates of some mineral waters greatly exceed the permissible limits of those found at the surface. Many polluted waters found in limestone soil are free from organic matter, because this has been oxidized to harmless products; and, if we rely entirely upon our reagents and microscopes, without regard to chemical change or source, we generally pass too favorably upon the water.

In forming an opinion from the sanitary survey, it is always safe to condemn a water which shows visible contamination beyond a reasonable limit of æsthetic permissibility; yet, when laboratory methods fail to find organic matter, or its associations, in water, we are not warranted in pronouncing it good, unless we know that these have never existed in it. The most that can be said in favor of the water is purely negative. On the other hand, it is often proper to condemn surface waters, even by the sanitary survey alone; but it is unwise for a chemist to rely very much upon the investigations made by inexperienced men. The most competent investigators give an opinion only after an examination of the source of supply and the whole drainage area, made by themselves or by others equally skilled.

The Chemical Analysis.

A chemical analysis determines the present and past pollution of

a water, and generally distinguishes between vegetable and animal matter, and, when the results are properly interpreted in the light of the sanitary survey, they often show whether a water is unsafe for drinking. Sanitary water analyses are usually reported in parts per million, so far as chemical results are concerned, because a litre of pure water at its maximum density contains exactly 1,000,000 milligrammes.

The total solids should not exceed 1,000 parts per 1,000,000 parts of the water, because the use of such water overworks the kidneys in removing the waste products from the body. The best drinking-waters contain usually not more than 500 or 600 parts of solid matter, which amount is nearly constant at all seasons of the year, and in all parts of a distributing water-works system; and it is not until this amount is exceeded that the water usually reveals the excess through the taste of its salts. Any decided variation from constancy in the amount of solids generally represents contamination and faulty management, and this is so marked in the water from "dead ends" that we sometimes find from thirty to forty times as much solid matter here as exists in the normal supply of the plant.

Loss on ignition, as determined by the refined methods adopted by some chemists, is not of especial interest to the sanitarian, since the principal value to be ascribed to this determination is from the qualitative indications of color and odor evolved. A blackening of the residue indicates organic matter, which disappears somewhat in proportion to its instability, and, when it evolves little or no odor, the organic matter is probably of vegetable origin. But, when the odor is strong and disagreeable, the contamination is generally from animal sources, or is highly concentrated, and the water requires no further investigation to show that it is polluted and unfit for domestic use.

The chlorine in ground waters or in uncontaminated streams is generally small, and is constant at the same season in all parts of a distributing water-works system; its amount should be nearly the same as that of the normal chlorine in other pure waters near by. Immediately after heavy rains, the amount is greatly reduced by dilution, and during a drouth it is excessive, but is the same at all points in one locality. Any variation from constancy in the amount of this element should be studied with care, and its cause ascertained. Chlorine is in this way an important means of detecting sewage contamination, but it is of no aid whatever in detecting vegetable refuse.

In an investigation of a public water-supply all tributary streams and rivulets should be examined; whenever marked variations in the chlorine occur, they are generally due to animal contamination, or to saline deposits near by. But the absence of this element, its small

amount, or its constancy in a water is absolutely no evidence that the water is pure and wholesome, because vegetable matter, which is practically free from it, may be there in any proportion, and thus render the water unfit for domestic use.

Free ammonia in water represents albuminous matter in a decomposing condition, and, when this is of vegetable origin, it is often noticeable, in Nesslerizing for the free and albuminoid ammonia, that the color is decidedly yellowish-green, instead of chocolate, and is especially distinct after the second or third fifty-cubic centimeter distillate. When the water contains urea, derived from urine, the organic matter is slowly decomposed, and the rate of distillation of the free and albuminoid ammonia becomes nearly constant after the first fifty cubic centimeters of each have been evolved; and a few of the last fractional distillates of albuminoid ammonia show nearly twice as much as the corresponding ones of the free. These facts are often of great service in detecting fresh sewage pollution. Surface waters suitable for drinking contain usually not more than .050 part of free ammonia to 1,000,000 parts of water, and often much less when the albuminoid exceeds this limit.

Albuminoid ammonia is developed from undecomposed nitrogenous substances when under the influence of a boiling solution of alkaline permanganate, and therefore represents pollution in a fresh and possibly dangerous condition. When a large proportion of this is evolved in the first part of the distillation, the organic matter is very unstable and in a putrefactive state, and, whenever the total free ammonia exceeds the albuminoid, the water, if it be a surface one, is generally stagnant and insufficiently aerated, and a suspicion is always entertained of sewage contamination in an advanced decaying condition. Waters that contain less than .050 part of albuminoid ammonia per 1,000,000 parts of water are organically nearly pure, and may generally be considered permissible, unless their origin is sufficient to condemn them; those that contain from .050 to .100 part are really dirty; while those that contain more than .150 part of albuminoid ammonia should be condemned as unsafe for human consumption. In an investigation of a recent typhoid-fever epidemic at Duluth, Minnesota, where two thousand persons fell victims to the disease, the city water, which was its cause, contained only .090 part of albuminoid ammonia per 1,000,000 parts of water. This one case shows how small an amount of albuminoid ammonia may be indicative of sewage pollution.

The oxygen consumed is generally in proportion to the carbon and hydrogen present in the organic matter of the water, and it often enables us to distinguish between vegetable and animal contamina-

tion. Permissible waters usually require not more than 1½ to 2 parts of oxygen per 1,000,000 to destroy their organic matter, and, when the amount exceeds 3½ or 4 parts, the water should be considered with suspicion. Whenever the amount of oxygen consumed is comparatively large and the albuminoid ammonia small, the contamination is usually of vegetable origin, and, when the oxygen is small and albuminoid ammonia large, the organic impurities are either of animal origin or concentrated albuminoids derived from vegetation.

Nitrites are compounds formed by the oxidation of ammonia in presence of weak bases, or are produced from nitrates through organic decay and bacterial action. They are very unstable salts, and frequently exist in cemetery drainage and badly-polluted surface waters. Any water having nitrites in measurable quantity should be regarded with suspicion, and many surface waters should be condemned by their presence alone.

Nitrates are the final products of oxidation of the nitrogen of organic matter, and therefore represent past pollution. Their normal amount in permissible water is generally very small, often-times not exceeding a mere trace, and their presence in a stream, or in the distributing system of a water works, in amounts above that of the original water supplying it, or the ground water near by, is evidence of contamination. This pollution is often due to faulty management in allowing suspended matter to accumulate in the mains; all "dead ends" should be flushed at frequent intervals.

The Microscopical Examination.

Under the microscope the suspended matter which separates from a water upon standing, like silt and other substances which might irritate the intestinal tract, can be studied with precision, and the results are often of great value in determining its sanitary quality. The writer has detected, in wells and streams used for domestic supply, particles of hair, excreta, oil globules, epithelia, and other filth derived from surface drainage or sewage, such as decaying vegetation, and it requires no argument to show that all such water is loathsome and unfit for domestic purposes. The microscope also enables us to study algæ and the animal micro-organisms of water, such as paramecia and other sewage ciliata which have been traced directly from the source of contamination to the point of supply; and we thus judge of the character of the water by knowing the habitat of these micro-organisms. The various entomostraca, such as cyclops and daphnia, can also be best studied with the microscope, although they can be easily seen with the naked eye. These organisms were once held as indicative of purity, but they are also found in water contaminated with drainage and we now know that their presence has no significance.

The Bacteriological Examination.

Bacteriology offers considerable service in the study of a water-supply, by determining the number of micro-organisms in a given volume of it. This science is particularly valuable in ascertaining the efficiency of filtration, and it also sheds some light on nearly all natural waters. Those from exceptionally pure sources, such as springs, deep wells, and rain or snow that falls at the end of storms, have but few bacteria in them, and the best ground and surface waters usually contain no more than 200 or 300 per cubic centimeter. The number of micro-organisms generally increases with pollution, until sewage is reached, with its millions per unit volume ; and, when there is a large number of sewage bacteria, it is probable that pathogenic germs are among the lot.

Since bacteria are absorbed from the air, the best surface waters must contain them, and no fixed standard of permissible limit is given. The number of micro-organisms depends entirely upon local conditions, always being more in thickly-populated districts than in mountainous and uninhabited regions. But some eminent authorities hold that a drinking-water should not contain more than 1,000 germs per cubic centimeter, and the sanitary authorities of some large cities, having municipal water works, advise the inhabitants to boil the water whenever the number of bacteria in it exceeds this limit. Systematic tests are frequently made to ascertain efficiency of filtration by determining the number of micro-organisms in the unfiltered and effluent waters ; and mechanical filters are now operated so perfectly by the use of alum cake as a coagulant that from 97 to 98 per cent. of the bacteria are removed. Some filter companies now guarantee to remove 96 per cent. of the micro-organisms, and reduce the albuminoid ammonia at least to .150 part per 1,000,000 parts of the water, and any system of purification that falls short of these results is unsatisfactory in proportion to the degree of failure.

Some investigators attempt to determine the wholesomeness of water by searching for its pathogenic germs, while others inoculate guinea pigs and rabbits with a culture medium which has been impregnated with the water and kept at the temperature of the human body for some time, and then study the effect with a hope that, if the water is disease-producing, physiological symptoms will develop characteristic of disease. But the numerous and tedious operations required for the identification of any species of bacteria, and the improbability of finding it, render the search almost hopeless at the beginning and usually fruitless in the end. This is not strange when it is remembered that only a few drops of water are operated on at a time. No polluted water, or even sewage, is teeming with disease-

producing germs, and they can be expected only in very inconsiderable numbers compared with those of other bacteria present.

There are but few cases on record where the Eberth bacillus has been satisfactorily isolated from water-supplies, and it is doubtful whether there has been a case on the American continent. The resemblance of this bacillus to certain water bacteria has often confused inexperienced investigators, and some bacteriologists distrust even their own results, and change their views after the "test of experience" has been made. But we can detect with certainty the *Bacillus coli-communis*, which is a normal inhabitant of the intestines of man and some other animals, and its presence is sufficient to absolutely condemn a water which contains it, in the absence of a system of thorough purification.

Detecting Origin of Pollution.

It is sometimes desirable to determine the origin of pollution of a water-supply. This is done by introducing into the various suspected sources some foreign substance that can be readily detected in the water, and yet will be harmless if taken into the system in small quantity with the water. By comparing the chlorine of city wells before, with the excess found some days after, a large amount of common salt and water has been added to adjacent privy-vaults, serious contamination is often detected. The celebrated case of contamination of the Lausen (Switzerland) water-supply was detected by placing a large amount of common salt in the suspected polluting stream, about a mile distant, on the opposite side of the Stockhalden, after which it appeared in the spring at the base of the mountain that furnished some of the inhabitants of the town with water. Lithium chloride, which is detected spectroscopically in minute traces, is sometimes used for the same purpose, and has given great satisfaction in legal investigations. The use of fluorescene, which gives a magnificent yellowish-green fluorescence to water, even in the smallest quantity, demonstrated an underground connection between the rivers Danube and Ach; and in the investigation at Duluth, above referred to, sodium fluorescene placed in a sewer appeared at the end of the intake, at a distance of several hundred feet from the shores of Lake Superior, in four and one-half hours, and remained for forty-two hours, thus showing, in the most satisfactory manner, the sewage contamination of the city water supply. Analine red, analine blue, and in some cases even Prussian blue have given satisfactory results in detecting the origin of pollution. Whenever any of these substances demonstrates a connection between a water-supply and sewers, privy-vaults, or other sources of contamination, the water cannot be used with safety for drinking, except after boiling or sanitary filtration.

AN EFFECTIVE SYSTEM OF FINDING AND KEEPING SHOP-COSTS.

By Henry Roland.

DURING the publication of four papers under the general title of "Cost-Keeping Methods in Machine Shop and Foundry," closed in the January issue of this magazine, letters from several firms were received by the author, asking for a simple and easily-installed cost-keeping system. All of these letters came from long-established, prosperous concerns, widely known in their respective fields, which included what might fairly be called all weights of metal manufactures.

Perhaps an adequate reply to this request for a simple and satisfactory system of shop-cost keeping is an impossibility, but, after careful consideration, it has been decided to give, in the present series of papers, the very simplest cost-keeping system known, which begins and ends with the "job-ticket" alone, as will be fully explained, and to follow this with a recital of the things done recently by some old and highly successful metal-working concerns which are endeavoring to find out what is really done in their own shops.

At first sight it seemed strange that the names of widely-known and highly reputable firms should be signed to these inquiries, which were all substantially the same, saying that the books and accounts kept failed to give information of indisputable accuracy, and that a need was felt for cost figures of absolute reliability, upon which future transactions could be based with the confidence born of certainties as to the history of the past.

But, as one considers the probable history of a long-established business which has grown from the humblest beginnings to a commanding position, it becomes clear that such manufactories are almost certain to rise from the early day of small things to very considerable size without the formulation and inauguration of a system of accurate shop account keeping, and that, when a business has become large, and is paying well, its internal operations are very likely to be continued in the path of least resistance. It is far easier to let a river run on and guess at what really underlies the strong current, than to go resolutely to work and spend the amounts of money and vital force needful to obtain an accurate knowledge of that river's bed.

A business is established, say, in the smallest possible manner, with one master workman of ability at the head of the few others for

whom he can find work. The mind of this master, in most ventures which reach final success, is wholly employed in perfecting his output and the means for its production. His accounts are kept in his head. He knows what his last work cost him, or so nearly that he can make a price for his next delivery; and that matter does not seem to him of nearly so much importance as how to better his product and increase his sales, which are problems increasing in importance with every step of advancement in public esteem and confidence. Very soon the "leading hand" appears, the right-hand man who has a memory and executive powers which can be exercised under the direction of another, and the "leading hand" becomes the depository of a mass of unrecorded information not possessed by the owner, and which he is glad not to be obliged to know, as this ignorance leaves his mind free for things of more present importance. As the establishment increases, it divides itself into departments, each practically under the exclusive control of some man whose fitness has gained him the post of authority, and so the natural-selection process goes on, the establishment having never been homogeneous since the day its founder first made a favorite workman "leading-hand." As it increases in size, it becomes every day more and more an assemblage of independent powers, operated still, it may be, in thorough harmony to a common end, but on wholly independent lines of management in different departments, and always approaching a point where these independent subordinate managers of either real or recognized authority are secretly or openly jealous of each other, and where each one sees that, the less any one else knows about the actual facts of his department, the better the chances are for his continuance in his position.

This is, I think, the real condition of every old and long-established manufactory which began in a small way, and, when this condition is once reached, the "main office" can ask in vain for detailed information. Only those who have attempted to institute a system of open, accurately-detailed accounts in a factory which has grown from nothing to eminence under the "leading hand" and "head-of-the-department" system of management can understand the obstacles which prevent the gathering and tabulating of such information as would enable the general manager to systematize an established business directed in detail by old employees on their own lines, who fully believe that, if they once tell all they know, others will be as wise themselves and the day of their reign will end forever.

The young and ambitious manager who takes the helm of a successful old firm finds at once that he is not to know the details of the factory of his own knowledge. He is to take his information at sec-

ond hand, or go without it. If he accedes to this, all is smooth, amiable, and prosperous on the surface, and perhaps a very wise young manager under such circumstances may be fully justified in a seeming acceptance of the situation, trusting to time and his own vigilance to gradually increase his knowledge of facts, and finally place him in a position to act with confidence of success. If the other course is taken, and the new manager makes a defined and persistent effort to compile actual shop performances, the result probably will be his removal from authority, as affairs speedily lead to a direct clash between the new man and the old, faithful, and indispensable workers who have, perhaps even from the first day the factory opened its doors, toiled earnestly in its interests, according to their individual lights, and have certainly greatly aided in its prosperity. Between a new manager who wants to know, and a force of old heads of departments who do know and will not tell, the board of directors is often called upon to arbitrate, with the full knowledge that to sustain the manager means no dividends for a year or two years, while to sustain the subordinate chiefs means the perpetuation of the mysteries and tyrannies which are so unendurable to the unfortunate new manager, and which the board of directors would gladly see abolished, but which they have not the courage to assail, in view of the results sure to follow. If self-preservation is the first law of nature, then the directors often cannot, or think they cannot, uproot the old system of management by departmental heads, because the house is not so strong as it looks and is rated to be, and a year or two without dividends would call public attention to matters which cannot safely be placed before the public eye.

If the new manager is intelligent and experienced, he knows that a general disturbance and overturning of shop routine will lead to those immediate losses which are sure to follow the disaffection of the workmen, who always resent a change in shop-methods, although he is perfectly certain that the introduction of a thoroughly organized system of passing work through the shops would surely lead to economies which would far more than repay the inevitable immediate losses, and would place the concern on an even basis with competitors, who always threaten the continuance of prosperity, I think, in a very visible and unmistakable manner, before a new manager is called in by the directors.

I am sure that I am not at all overstating the case of the new manager and of management by departmental heads. Nor do I err in regarding such a situation as always perilous for all concerned. The old employees have a seemingly just cause, based on long and faithful and successful service, than which there is no better certificate

of merit. Yet the concern sees itself undersold, although it has made all possible concessions to retain trade. Besides, the directors and the new manager well know that no house can ever stand still. A business must advance, or must fall back, and to fall back steadily means present extinction.

In this dilemma of the directors, the new manager, and the old heads of departments, all equally eager for the success of the business, and yet so hopelessly antagonized as to the details by which that success shall be reached, what is to be done?

First of all, it is absolutely certain that the old sub-managers, the departmental heads who really direct the internal economy of the concern and control the labor cost of the output, will not of their own motion make work cost less in the future than in the past. Hence in some way work must be traced through the shops, establishing a reliable record as it goes, because comparison of reliable records is the first step toward a reduction of cost of product.

But how?

Evidently best by some means which will avoid any open clash at the outset. Although the simple means here proposed may seem inadequate, and is offered with some diffidence by the writer, it appears that the job-ticket may be made to serve all needful purposes in manufactures of small weight, and perhaps in all metal-working establishments which do not at present know what is being done in their own shops.

The manager can say to any head of a department, no matter how lordly and autocratic a despot he may be: "Mr. Brown, I am truly glad to be associated with a man of your long experience and ability, and I can assure you that not the slightest change will be made in your department without your approval, so long as I can prevent it." And the new manager can make this diplomatic speech with a close approach to certainty that it will place matters on a footing of at least ostensible agreement and harmony as between himself and his subordinate so addressed, and that for a certain time, and perhaps permanently, there will be a plainly-manifested desire on the part of the departmental head for joint consultations over matters of shop policy, and an evident willingness to accede to proposed reforms which will leave him still in control of his original territory. The cordiality of the subordinate may be not altogether sincere, but, as he wishes to retain both his place and his authority, and sees a way opened to keep both, he is almost certain to declare with at least an appearance of hearty alacrity in favor of all possible suggestions of improvement in methods.

This basis of action must be established, unless the general resig-

nations of heads of departments are resolved upon, which is always unjust in a certain sense, and always, without qualification, costly for a time to the manufactory. Having established this platform of mutual action, each department manager should be consulted with the utmost patience in regard to improvements in production; and the importance of tracing work through the establishment generally, and particularly through the important department under his own control, should be enlarged upon, until finally the absolute necessity of a rough-stores room and a finished-stores room is agreed upon. When this point is once reached, all the rest is perfectly easy, and becomes a mere matter of time and course. The rough-stores room and finished-stores room may even be departmental, at first, if needful to smooth action, for any rough-stores and finished-stores room system involves the job-ticket, without which nothing can leave the rough-stores room or enter the finished-stores room, and without which, in light work at least, no workman can draw pay for his work, no matter what system of labor recompense is adopted,—piece, day, or premium pay. It at once begins to furnish the main office with an itemized and perfectly accurate account of all the details of shop method and management which have hitherto been the preciously-guarded secrets of the department Autocrat, who, like the gigantic Troll of Scandinavian folk-lore, becomes powerless the moment light reaches him.

The job-ticket is by no means new; it is employed in some form in every system of shop-cost keeping. Nor is it new to rely on the job-ticket alone, as is here proposed. The De La Val shops (all of whose shop-blanks were given in the November (1897) issue of this magazine, beginning on page 230) make the job-ticket (p. 233) cover almost as wide a field as it is here proposed to have it occupy. It is absolutely needful, in order to establish a record of factory operations, that a rough-stores room in charge of a rough-stores keeper, made responsible for all that comes into it and all that leaves it, and a finished-stores room under entire control of a finished-stores keeper, be provided. All work done in the shop must have a starting-place, a way-bill on which the events of its passage through the hands of the workmen can be recorded, and a place of delivery where the finished work, and its history as recorded on the way-bill or job-ticket, are received together. There must be no possibility of anything whatever making its way out of the rough stores room, or through the shops, or into the finished-stores room, without an accompanying job-ticket, there must be no possibility of a halt by the way without a record of the delay on the job-ticket; and no labor can be paid except from credits entered on the job-ticket. When

these conditions are filled, the flat-cost or stock-and-labor-cost come at once into the possession of main office.

And, if a percentage of expense, based on the "number of hands in work," be established, total costs can be at any time computed from the job-ticket footings by one multiplication. Perhaps no better or more thoroughly practical system of estimating the percentage to be added to prime-cost to give total-cost can be devised than that based on the number of hands in productive work. If this be accepted, then the number of hands in work, stamped on the job ticket for each day of its passage through the shop, gives the correct average percentage to be added to prime cost to give total cost of the complete job.

Like all other general rules, this "hands in work" percentage would find an exception in unusual occurrences, as in the case of very few men working on a non-legal holiday. But for all purposes of average accuracy, which is all that can be obtained by any system of total-cost estimating, the number of hands in work seems to be nearest to a correct deciding factor.

While the rough-stores room and finished-stores rooms are here spoken of as necessities of successful manufacturing, it is, of course, to be understood that, at some point of ponderability, transportation of pieces under construction for the mere purpose of safe keeping becomes impracticable; and, when work comes to such weight that its handling forms an important feature, the establishment becomes a "shop" instead of a "factory," and both the rough-stores room and the finished stores room disappear. The exact weight of single pieces at which the manufactory changes to the shop has not been determined. The Reed lathes are made on manufactory lines, and all farm-machinery, including traction-engines, can start from the rough-stores room and end in the finished-stores room. But, while the job ticket is an indispensable adjunct to the rough-stores and finished-stores rooms, it can exist independently of them, and the first form given is that of a job-ticket adapted to machine-work of the heavier class, where the pieces undergo different operations at the hands of different workmen and occupy considerable time in finishing. The job ticket for heavy shop work is a more complicated affair than that for single operations on small pieces, of which hundreds or thousands may be handled in a day by one hand; nevertheless, it seems perfectly competent to fully record all the important items of the shop history of the heaviest pieces.

It is true that common experience indicates the propriety of demanding as little as possible from the workman in the way of clerical labor, but it is the rule, I think, to use the workman's time-slip, on

which he enters his time for each day, in charges against the job or jobs on which he may be employed; the same time-slip serves to distinguish common time from over-time, since the two are usually paid different hour-rates to the same individuals.

If the workman can correctly record his time on one slip of paper, he can do so on any, and there is no apparent reason why two or more workmen should not record their time on the same job-ticket, provided with a sufficiency of individual spaces of time-entry.

This makes the collective job-ticket appear possible, though it may prove in practice one of those labor-savers which are successful in some hands and failures in others.

The advantage of the collective job-ticket is that a single ticket may be made to give the entire labor-cost of an elaborate construction, in the production of which many hands have been used, while the simple single-day time-slips are unavailable as a source of information as to total labor costs until after they have been through the hands of the cost-clerk, who extends, collects, and tabulates the mere hour-charges recorded.

To meet all the contingencies, an example has been taken from actual practice in the finishing of a Corliss cylinder, 28 inches by 60, which was a "hurry" job, and was pushed day and night, requiring over time, and this under a shop system which charged the time of helpers to individual pieces of work. A simpler method is to charge the helper-time to the expense account in a lump.

If the pay roll is made up from the time-slip or job-ticket, collective or otherwise, then the collective job-ticket must be out of the shop and in the hands of the paymaster's department for at least part of a day in each week.

It is, however, in most cases far better, in heavy shops, to make up the pay-roll from individual workmen's brass checks, consecutively numbered. A workman, on leaving the shop, takes his check from a hook on a board in the porter's office, and deposits the same in the check box as he next enters the works. By this system the pay-roll time can be checked up within an hour after starting-time each half-day, so that payments on Saturday up to Saturday night are made possible, if desired. Usually payment is to Friday night, if made on Saturday, and, with the brass time-check system, the job-ticket has nothing to do with the pay-roll, and can remain in the shop until the job is completed.

In addition to the individual brass time-check, this writing supposes each department of the shop to be furnished with the well-known self-dating clock-operated stamp, by which the correct time stamp may be affixed to each job ticket as often as needed, with per-

Order 2917. Machine 34. Drawing March 10, '94.
430 (Hands in work). I have all material in hand. John Brown, Foreman.
February 7, 1898. 9.30 A. M. John Smith, Job Master.

Foreman's clock date, Feb. 7, '98. 10 A. M.

Date given to workmen. (Clock Stamp.)	Workman's Name.	No. Tool.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Feb. 7, '98.		Overtime.														
10.30 A. M.	A. Smith	5		5	10	10										
Feb. 7, '98.		Overtime.														
10.30 A. M.	B. Smith (helper)	H		5	10	10										
Feb. 7, '98.		Overtime.														
10.30 A. M.	C. Smith	5		10	10	7										
Feb. 7, '98.		Overtime.														
10.30 A. M.	D. Smith	H		10	6½											
Feb. 10, '98.		Overtime.														
7.00 A. M.	E. Smith	7					10	10	10	6½						
		Overtime.														
	F. Smith	H					10	10	10	6½						
(Fold here)																
Feb. 14, '98.		Overtime.		5		5										
7.00 A. M.	G. Smith (Fitter)	F		10	10	10	5									
Feb. 14, '98.		Overtime.			5	5										
7.00 A. M.	H. Smith	F		10	10	10	10	9½								
Feb. 14, '98.		Overtime.														
7.00 A. M.	I. Smith	H		10	10	10	10	5								
Feb. 14, '98.		Overtime.					7									
7.00 A. M.	K. Smith	F		10	10	10	10									
Feb. 14, '98.		Overtime.														
7.00 A. M.	L. Smith	F		10	8	10	10	10								
Feb. 16, '98.		Overtime.														
9.00 A. M.	M. Smith	F				8	3									

Operation Finished.

Feb. 10, '98. 7.00 A. M.

Feb. 14, '98. 7.00 A. M.

Feb. 20, '98. 2.00 P. M.

Feb. 21, '98. 10.30 A. M.

Total Hours Labor, - - 422
Total Labor Cost, - - - $162.00.

John Smith, Job Master.

fect accuracy and the least possible labor. No system of shop records should be favored which reduces the responsibilities of the foreman, but the foreman's labor should be reduced by all possible methods.

A sample form of the job ticket is illustrated on the opposite page, perhaps more extensive than will often be necessary.

The job-ticket must originate with the order department, of course, and will henceforward be supposed to be issued, directly, by the "job-master," and by him transferred to the foreman who is to have charge of the work.

The job-master's self-dating clock prints the date and also the number of hands in work, which is changed as occasion requires, so that the expense percentage to be added to the labor-costs recorded on the card is defined.

The first item of the first dated line of the card is the number of men in work and the date,—hour and minute,—followed by the job-master's own stamp. Since this date is printed from the clock-stamp, it fixes beyond question the hour on which the job-ticket was made. The same line continues with a statement that the foreman has all needed stock for the job in hand, and is followed by the foreman's stamp and, at the end of the line, a foreman's clock-stamp date, which fixes the time at which the order was accepted by the foreman from the job-master.

The remainder of the card is filled with spaces for two weeks' work of each of twelve individual workmen, with date spaces at the left, which the foreman fills with clock-stamp dates, as he delivers the job-ticket in succession to the hands who are to work upon it, and a similar date space at the right, which is filled as the job-ticket is returned to the foreman at the completion of each stage of the work.

By this collective job-ticket, as shown in the illustration, the entire labor-cost of boring, milling, drilling, tapping, and fitting this 28x60 Corliss cylinder is given as 422 hours. The machinist's time and laborer's time are given in separate items, with the over-time and common time distinguished from each other. The tools used are specified by their shop numbers. The machine number and detail-drawing date are given, all dates are recorded, the expense percentage is fixed, and, with the least possible labor of the cost-clerk, the aggregates and the total cost can be obtained, and, without any additional book-keeping, the job-ticket furnishes a complete shop-history of the job, and can be filed, card-index fashion, as a completed record.

This case of the Corliss cylinder may be regarded as extreme in respect of number of separate entries; perhaps less than twelve workmen's names on one card would be better. Two cards with six names each could be used; still, if the job-ticket is to be used at all in the

collective form, it should be used in such amplitude as will enable all details of each single job to be recorded on the one ticket.

The great advantage of the collective job-ticket lies in the immediate availability of its record. With the single-man, single-day time-slip, aggregate information is to be had only after all the single time-slip entries have been combined in a new statement, involving clerical labor, the possibility of clerical error, and an added document to be verified only from the orginal time-slips, at considerable expenditure of time and labor.

These advantages of the collective job-ticket seem to entitle it to careful consideration for heavy work regarded as insusceptible to factory methods.

For less complicated operations, where each job-ticket covers a single operation, as the job-ticket is commonly used, the collective form seems to have the same advantages, as will be shown subsequently, although it has not, so far as known, been used in the collective form in actual practice.

NOTABLE SPEED-TRIALS OF BRITISH LOCOMOTIVES.

By Charles Rous-Marten.

IT is extraordinarily difficult to find out accurately how fast a British locomotive can run.

As a rule, the railway companies and the locomotive engineers seem greatly to prefer that the public should know nothing about it. Even for official information as to locomotive capabilities, really exhaustive tests are rarely made. When it is ascertained that an engine can do the duty required, that is sufficient. The British companies do not desire increased speed; they think it means enhanced expense; they doubt whether the public like it; they are readily influenced by the ignorant clamour about "excessive and dangerous speeds" which some foolish, or cowardly, or obsolete, persons so frequently raise without the slightest grounds.

No sense of patriotism inspires British railway officials with a resolution to break a foreign record. Quite the contrary. The establishment of a new record by America, for instance, merely elicits a smile of complacent gratification that expense is not incurred for such purposes in England. "Railways," say the British authorities, "are purely commercial undertakings, carried on for money-making purposes, and not for record-breaking, or racing, or anything of that sort." If a competing line goes ahead, that has to be matched; but the patriotic anxiety with which railway records are striven for in America is unknown in Great Britain, so far as the railway companies themselves are concerned. And so any display of exceptional velocity is, as a rule, discouraged. It is only now and then, when a novel type of locomotive comes out, that permission can be obtained to "let her out" and "show her paces."

One such occasion has occurred lately, and the outcome has been the breaking of all previous British records for maximum speed.

Before describing this interesting experiment, I will review briefly the previous records in British practice. It is greatly to be regretted that so many notes of speed-performances which would have been most valuable, if manifestly trustworthy, have been vitiated by obvious carelessness or error. This applies to both sides of the Atlantic. Where timings for short distances are given only to the even minute, where station-distances over a whole journey are given only to the even mile,—no other distances being supplied—and where the times

of adjacent distances are palpably inconsistent with the "record" length put forward,—it is impossible to accept them as authentic for scientific purposes. For, as results, one sees a speed of 87 miles an hour claimed for one length, when the two adjacent lengths—that preceding and that following—show rates of only 55 or 60 miles an hour; when a distance of 2.8 miles is claimed to have been done in "2 minutes," whereas the "log" shows the time to have been 2½ minutes; when a second station is shown as having been passed half a minute before the previous station was passed; and when a train is represented as coming to a stand 1 minute after passing a point 1.7 mile distant. Such things have come under my personal notice, in Great Britain and America alike.

One of the earliest speed-trials made with engines used in modern times was that conducted by Mr. Brunel, Mr. (afterward Sir Daniel) Gooch, and Mr. Charles Sacré (subsequently engineer-in-chief to what is now the Great Central Railway), on the Great Western line, early in 1848,—just fifty years ago. In 1884 Mr. Sacré, then the sole survivor of that eminent engineering trio, placed at my disposal his notes taken on the occasion in question. They proved that on Brunel's famous 7-foot gauge, three different engines of Gooch's equally famous class of 8-foot single-wheelers—"Iron Duke," "Great Britain," and "Courier"—failed to reach a higher speed than 78.2 miles an hour, when specially tried at their utmost power down falling gradients of 1 in 100. A mile in 46 seconds was their best possible. Yet it has been a long-received myth that these engines often ran at 80, 90, and even 100 miles an hour! The same engines ran until May, 1892, when the 7-foot gauge was abolished, and I made many trips with them, but only on two occasions did they equal the speed of 1848, although having the advantage of higher steam pressure.

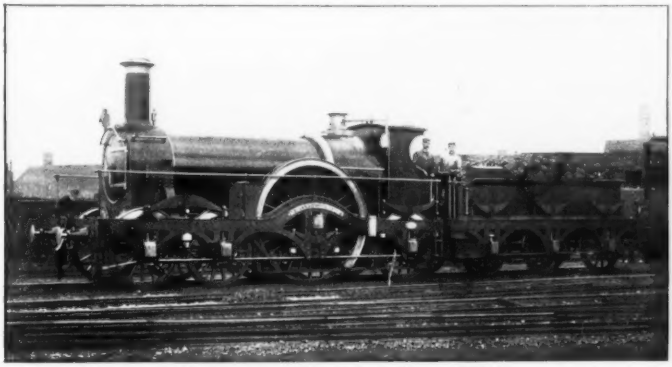
It is alleged that Trevithick's London and North Western engine "Cornwall" (built in 1847, with the boiler below the axle, and still running as a locomotive of the ordinary type, though retaining her 8½-foot single driving-wheels), and McConnell's 7½-foot single-wheeler, No. 373, each attained, on the gauge of 4 feet 8½ inches, a speed of more than 79 miles an hour in special trials; but the methods seem to have been of the "rough and ready" order, and no adequate records have been left.

Then, in 1853, the 7-foot gauge again came to the front. One of Mr. Pearson's ten-wheeled double-bogie tank engines on the Bristol and Exeter line, having single-drivers 9 feet in diameter, attained in two special trials, down the Wellington incline of 1 in 81, speeds of 80.0 and 81.8 miles an hour respectively. At a later period these locomotives were rebuilt, with 8-foot single-drivers; testing one of

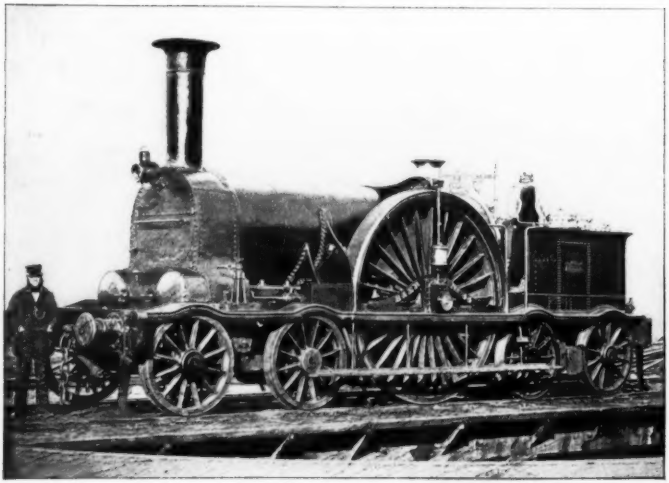
LONDON AND NORTH WESTERN "CORNWALL," NO. 3020. BUILT 1847.
Cylinders 17½x24; driving wheels 8 ft 6 in.; by J. Trevithick. Originally had the boiler below the axle, and was rebuilt as shown by Mr. J. Ramsbottom. It was in the exhibition of 1851, and is still at work.

them down the same incline a few years before the 7-foot gauge ceased to exist, I also obtained a rate of 81.8 miles an hour.

For many years after 1853, however, that rate of a mile in 44

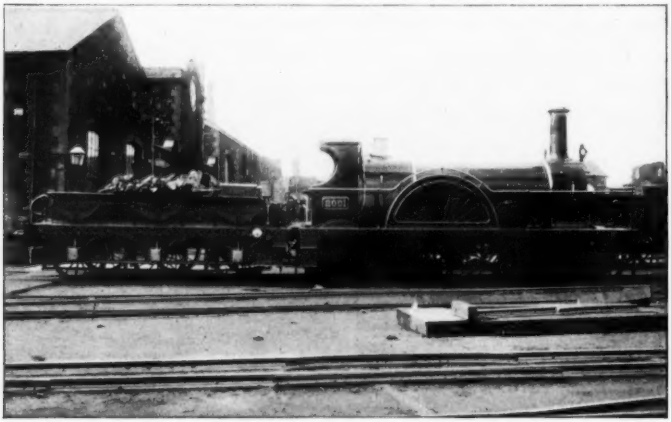


GREAT WESTERN "PROMETHEUS," 7-FOOT GAUGE.
Cylinders 18x24; driving wheels 8 ft.; by D. Gooch.



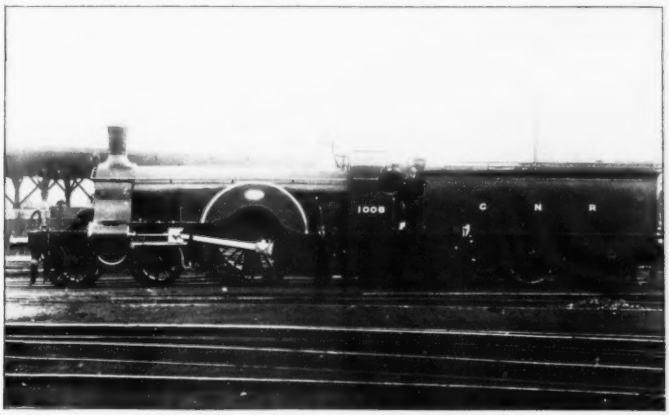
BRISTOL AND EXETER NO. 44; ORIGINAL FORM.
Cylinders 16½x24; driving wheels 9 ft.; by J. Pearson.

seconds remained an absolute "record." Nor is there absolute certainty as to the time when that record was first broken. In 1870 the late Mr. Patrick Stirling brought out on the Great Northern Railway



BRISTOL AND EXETER NO. 2001. SAME CLASS AS NO. 44, REBUILT, WITH TENDER AND WITH 8-FOOT DRIVING WHEELS.
Cylinders 18x24; driving wheels 8 ft.; by J. Pearson.

the first of those splendid 8-foot "singles" which have since won world-wide celebrity. Phenomenal velocity was soon claimed for these new-comers, but no authentic accounts exist of any speed exceeding 75 miles an hour during their earlier days. Their author reported a trial run of 15 miles in 12 minutes with sixteen coaches, but the time was admittedly taken in very loose fashion, and, on an attempt being made to repeat the performance, it proved impracticable with such a load. But, with new boilers, increased steam-pressure, and cylinders enlarged by boring out, these engines improved upon this maximum. Testing one down a long bank of 1 in 200, in 1893, I obtained a speed of 80 miles an hour. The driver maintained that this was the best it could do. However, on giving it another notch, 81.8 was reached. But an additional notch brought the rate down to 78,



GREAT NORTHERN RAILWAY NO. 1008.
Cylinders 19x28; driving wheels 8 ft. 1 in.; the other five in this class have 19½ in. cylinders; by P. Stirling.

owing to back pressure in the cylinders, the engine being unable to exhaust with sufficient rapidity. Later, by different management, I obtained a speed of 83.7 with one of these engines down 1 in 200, and I am convinced that down a steeper grade still faster travelling could be done. But the Great Northern line does not afford any great length of grades steeper than 1 in 200, and so the trial has not taken place. The unique length of these engines' piston-stroke,—28 inches,—while enhancing their pulling power, is possibly disadvantageous as regards the attainment of extreme speeds.

On this ground, in fact, they have been beaten by Mr. Stirling's other class of single-wheelers, those with drivers 7 feet 7 inches and

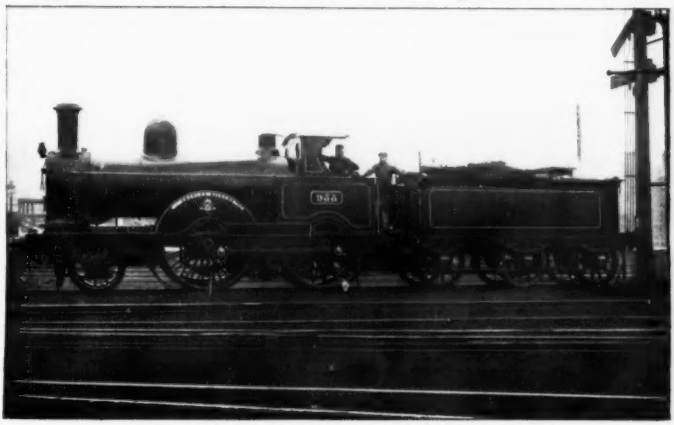
inside cylinders 18½ × 26. With these I made several special speed-trials with interesting results. One which had cylinders bored out to 18⅞ inches attained successively 81.8, 82, 83.7, and finally 84.1 miles an hour, the fastest mile being done in 42.8 seconds. This occurred on two different occasions. I was not satisfied that the *maximum possibile* had been reached, but the driver was nervous about attempting any more, and so the record rested there for awhile. It was promptly equalled, however, by three different Midland engines of virtually identical dimensions, but possessing what I deem the material advantage of leading bogies in lieu of the radial axles under the leading end of the Great Northern inside-cylinder single-wheelers. Also one of Mr. W. Dean's "singles," 7 feet 8 inches, used for express work on the Great Western since its conversion to the gauge of

GREAT NORTHERN RAILWAY NO. 235.
Cylinders 18½x26; driving wheels 7 ft. 7 in.; by P. Stirling.

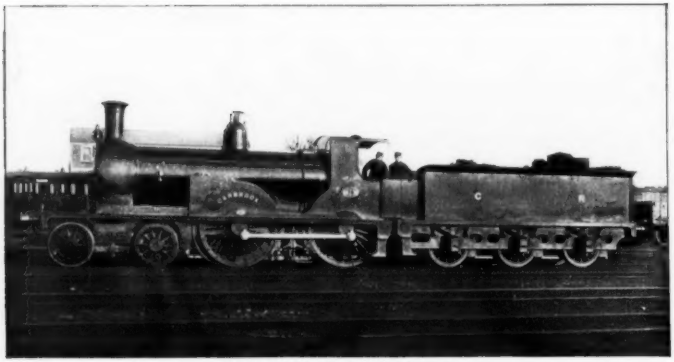
4 feet 8½ inches, ran them very close with a maximum of 83.3 miles an hour. Meanwhile various classes of coupled engines on several railways had come markedly to the front, and, alike on the London and South Western, London and North Western, Midland, and Caledonian lines, had run at speeds of 80 to 82 miles an hour. And now several classes of coupled engines pushed forward into the front place of all. During and after the famous "Race to Aberdeen" of 1895, I had the opportunity of testing coupled locomotives on the London and North Western, North Eastern, and Caledonian Railways respectively, at speeds ranging as high as 85.7 miles an hour, or a mile in 42 seconds. The three classes which had reached this point differed in a remarkable degree. The London and North-Western engine was by far the smallest, having cylinders only 17 × 24, with coupled

MIDLAND RAILWAY NO. 1865.
Cylinders 18½x26; driving wheels 7 ft. 6 in; by S. W. Johnson.

wheels 6 feet 6 inches and weighing only 32.7 tons. The Caledonian engine had cylinders 18 × 26 and coupled wheels 6 feet 6 inches, and weighed 47 tons. The North Eastern locomotive had cylinders 19 × 26, and 7-ft. coupled wheels, and weighed 51 tons. Yet each managed to break all the past records of the single-wheelers.

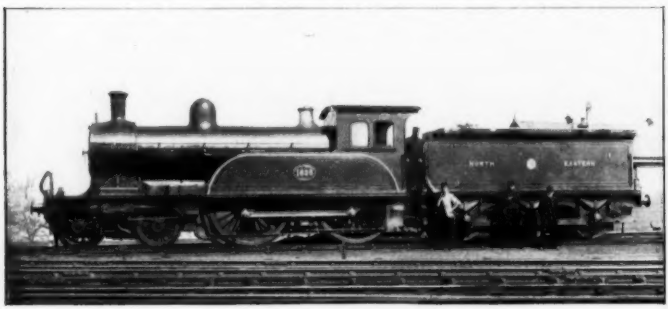


LONDON AND NORTH WESTERN "CHARLES DICKENS."
Cylinders 17x24; driving wheels 6 ft. 6 in.; by F. W. Webb.



CALEDONIAN RAILWAY NO. 79.
Cylinders 18x26; driving wheels 6 ft. 6 in.; by D. Drummond.

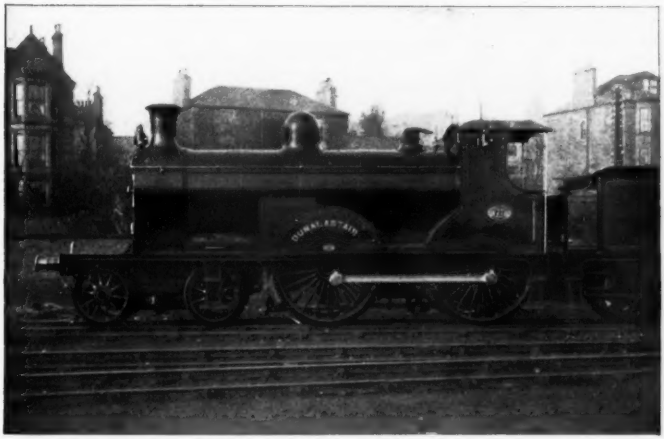
So did one of Mr. F. W. Webb's 3-cylinder compounds on the London and North Western, with high-pressure cylinders 15 × 24, low-pressure cylinders 30 × 24, and four 7-foot single drivers; so also did Mr. Worsdell's single-wheel two-cylinder-compounds with 20-inch high-pressure cylinders, 28-inch low-pressure cylinders, and wheels 7 feet 7 inches. Each of these succeeded in covering the mile in 42 seconds = 85.7 miles an hour. Then, in 1896, Mr. J. F. M'Intosh's splendid "Dunalastair" engines on the Caledonian line, with cylinders 18¼ × 26, coupled wheels 6 feet 6 inches, and vast boiler power, "tied" the record of 85.7 in several special trials which I was able to make. Even at that high point they were not working to the limit of their capacity, but necessities of traffic-working prevented me from pushing them to their utmost.



NORTH EASTERN NO. 1638.
Cylinders 19x26; driving wheels 7 ft. 1 in.; by W. Worsdell.

NORTH EASTERN NO. 1517; COMPOUND.
Cylinders 20 and 28 by 24; driving wheels 7 ft. 7 in.; by T. W. Worsdell.

Toward the end of 1896 I made another trial of one of the Great Northern inside-cylinder single-wheelers, 7 feet 7 inches, down a long bank of 1 in 178, 1 in 200, and 1 in 264. This particular engine had 18¾-inch cylinders. The previous record by this class was steadily overhauled at each mile, and then was passed, a mile being run in 41.8 seconds, or at the rate of 86.1 miles an hour, while three successive quarter-miles were done in 10.4 seconds each, repre-



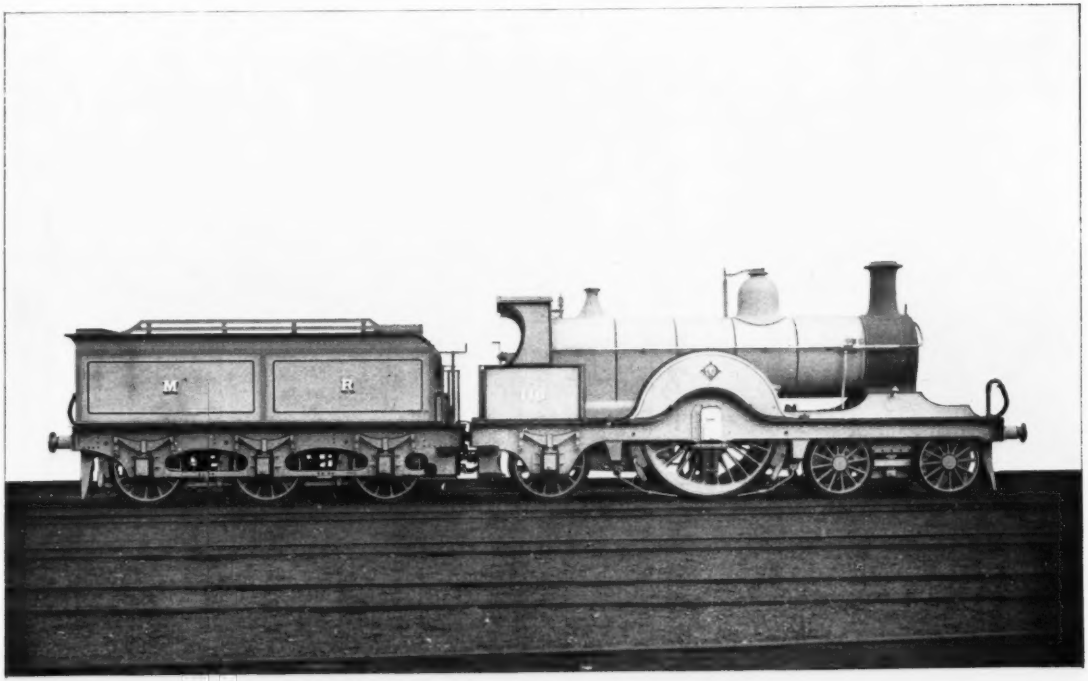
CALEDONIAN RAILWAY "DUNALASTAIR," NO. 721.
Cylinders 18¼x26; driving wheels 6 ft. 6 in.; by J. F. M'Intosh.

senting a speed of 86.5 miles an hour. I do not think the limit had been reached, but most vexatiously an adverse signal compelled a slackening to 10 miles an hour, and the way lost could not be recovered.

In the autumn of 1897, however, when making special observations with a London and North Western train drawn by two of the coupled engines 6 feet 6 inches already mentioned, descending a grade of 1 in 132, two miles were done in 41 seconds each, or at the rate of 87.9 miles an hour; and the next day one of the same engines, running down 1 in 147, following a 4-mile descent at 1 in 75, did a mile in 40.8 seconds, equal to 88.2 miles an hour.

But Queen Victoria's diamond jubilee year was not to close without a still more notable advance in speed. Mr. S. W. Johnson brought out on the Midland Railway five new single-wheel express engines of singularly fine proportions and handsome appearance. They have inside cylinders 19½ × 26, 170 pounds' steam pressure, and single-drivers no less than 7 feet 9 inches in diameter,—the largest wheels ever employed with inside cylinders on a gauge of 4 feet 8½ inches. With these superb locomotives I made several special speed-trials without breaking the record. But finally, testing one of these engines with a load of 150 tons down a long grade, 16 miles, mostly at 1 in 200, I obtained the following remarkable figures for five successive quarter-miles: 10.2 seconds, 10 seconds, 10 seconds, 10 seconds, 10.2 seconds. Thus the engine ran for ¾ mile at the rate of exactly 90 miles an hour, the speed for the whole mile being 89.5. Unfortunately, after the third quarter-mile, which was done in 10 seconds, a rising gradient was encountered, which steadily lowered the rate. Had the falling grade continued a little longer, or had it been somewhat steeper, I see no reason to doubt that even a slightly higher velocity might have been reached, as the engine was not only steaming freely, but exhausting her waste steam well, when the highest point was reached. A speed of 80 miles an hour and upward was maintained for 13 consecutive miles. The travelling was admirable in its smoothness and absence of oscillation.

It may be of interest to explain the method that I always employ in testing speeds. While mechanical speed-indicators, such as the Boyer, Westinghouse, etc., may doubtless work well in favourable circumstances, they require special attachment and fitting. It is preferable, therefore, to perfect a system which can be applied to any engine and train, provided that mileposts or distance-points can be recognised. My method is to use three excellent chronographs—one with the split-seconds movement—and a watch. At each quarter-mile-post one instrument is started, and another simultaneously stopped. At the end of each mile the split-seconds-hand is split,



A JUBILEE YEAR RECORD-MAKER. MIDLAND RAILWAY NO. 116.
Cylinders 19½x26; driving wheels 7 ft. 9 in.; by S. W. Johnson.

and, at the end of the total length selected for the trial, the chronograph also is stopped, and the times of passing stations, signal-boxes, etc., are noted by the watch. Each observation is at once noted down, either by myself in a note-book open and in readiness, or by a shorthand assistant to whom it is orally dictated. In this way the disturbing element of personal equation is virtually eliminated, and a thoroughly effective triple check is secured. No less elaborate method can be regarded as entirely trustworthy.

This article would be incomplete without some reference to certain noble trials of speed which have taken place between rival companies. Most prominent among these were the celebrated "races" between the East and West Coast routes, from London to Edinburgh and Aberdeen respectively, which occurred in 1888 and 1895.

Viewed in the light of the experiences of 1895, the "race" of 1888 now seems a very mild affair, every record made in the former year having been beaten in the latter. Still, at the time, the performances of 1888 were remarkable as transcending anything previously accomplished, and even to this day they possess some interest. Briefly, the race from London to Edinburgh in 1888 was won decisively by the East Coast—that is to say, by the Great Northern, North Eastern, and North British companies, their best time for the 393 miles to Edinburgh being 7 hours 27 minutes, including a 20 minutes' stop for lunch. The best authentic times for the various stages of the journey were:

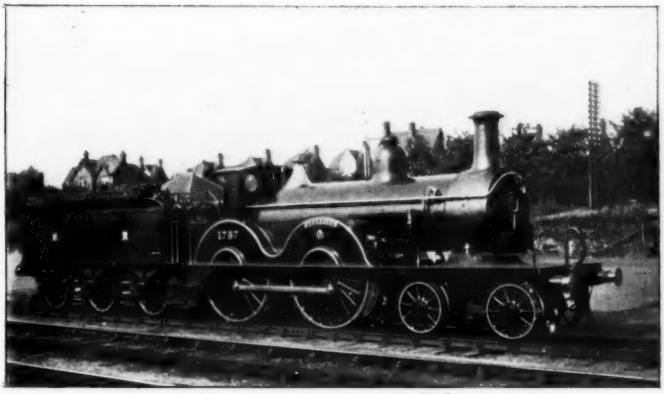
STAGES	Distance.	Time occupied.
London-Grantham	105½ miles	1 hr. 46 min.
Grantham-York	80¾ "	1 hr. 28 min.
York-Newcastle	80½ "	1 hr. 21 min.
Newcastle-Edinburgh	124½ "	2 hrs. 6 min.

Curiously enough, not one of these best intermediate times seems to have been made on the day when the best complete journey was accomplished.

On the West Coast the journey of 401 miles was done,—by the London and North Western and Caledonian respectively, in 7 hours 38 minutes. The best intermediates, of which only one—the first—was done on the best "through" day, were as follows:

STAGES.	Distance.	Time occupied.
London-Crewe	158 miles	2 hrs. 46 min.
Crewe-Preston	51 "	0 " 50 min.
Preston-Carlisle	90¼ "	1 hr. 30 min.
Carlisle-Edinburgh	100¾ "	1 hr. 42½ min.

The engines used were as follows: East Coast, London to York, Great Northern single-wheelers (1) with driving-wheels 8 feet 1 inch in diameter and outside cylinders 18×28, or (2) with driving-

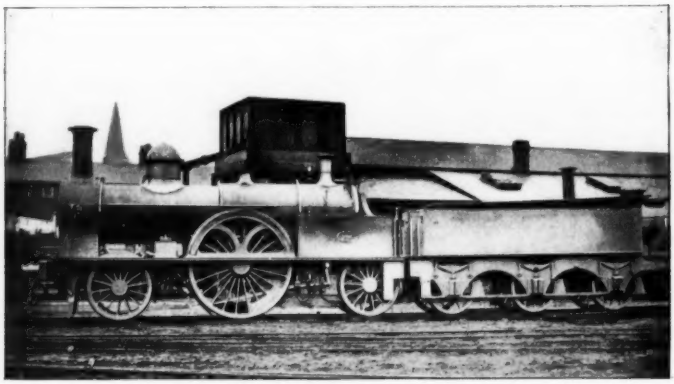


MIDLAND RAILWAY NO. 1757, WHICH RAN 81.8 MILES AN HOUR.
Cylinders 18x26; driving wheels 7 ft.; by S. W. Johnson.

wheels 7 feet 7 inches in diameter and inside cylinders 18½×26. York to Edinburgh, North Eastern coupled engines, either non-compound with 7-foot drivers and cylinders 18×24, or compound (Worsdell-Von Borries') with wheels 6 feet 8 inches and cylinders 18 and 26×24. West Coast, London-Crewe, London and North Western, singles 7 feet 6 inches, outside cylinders 16×24; Crewe-Carlisle, coupled 6 feet 6 inches, cylinders 17×24; Carlisle-Edinburgh, Caledonian, 7-foot single, inside cylinders 18×26. The maximum speed attained on each route was estimated as 76.5 miles an hour.

As to the still more remarkable "Race to Aberdeen" in 1895, little need be said, as its marvels are fresh in the public memory, and are frequently revived in controversies as to rival "records."

Briefly, the victory in this case went to the West Coast route, over which the longer journey of 540 miles from London to Aberdeen was accomplished with a light train of 70 tons in 8 hours 32 minutes, or at the average rate of 63.2 miles an hour, including all stoppages, or 64.3, excluding stops. It is only fair to remember, however, that the East Coast did not compete on this final night, having elected to rest on the laurels won the night before, when the shorter distance of 523 miles was done in 8 hours 40 minutes, beating the West Coast on that occasion by 15 minutes. It is interesting to note, moreover, that, on the last three nights of this historical competition, the East Coast journey from London to Edinburgh was performed in 6 hours 44 minutes, 6 hours 41 minutes, and 6 hours 19 minutes, as compared with 7 hours 27 minutes,—the best of 1888. In the earlier in-



LONDON AND NORTH WESTERN NO. 373; IN THE EXHIBITION OF 1862, "EXTRA LARGE BLOOMER CLASS."
Cylinders 18x24; driving wheels 7 ft. 6 in.; by M'Connell.

stance, however, there was an extra delay of 15 minutes for lunch. Still, an allowance made for this handicap, the record of 1895 beat that of 1888 by 53 minutes,—a notable advance.

All but one of the quickest stage times were made on the best night by each route. They were as follows:

WEST COAST.

Stage.	Distance.	Time occupied.	Speed. (Miles an hour)
London-Crewe	158 miles	2 hrs. 27½ min.	64.3
Crewe-Carlisle	141¼ "	2 " 6 "	67.2
Carlisle-Stirling	117¾ "	1 " 53 "	62.5
Stirling-Perth	33 "	0 " 33 "	60.0
Perth-Aberdeen	90 "	1 " 20½ "	66.7

On the "record" night, the run of 150¾ miles from Carlisle to Perth was made without a stop, but at a slower speed,—*viz.*, 60.5 miles an hour.

EAST COAST.

Stage	Distance.	Time occupied.	Speed. (Miles an hour)
London-Grantham	105½ miles	1 hr. 42 min.	61.9
Grantham-York	80¾ "	1 " 16 "	65.3
York-Newcastle	80½ "	1 " 18½ "	61.5
Newcastle-Edinburgh	124½ "	1 " 54 "	65.5
Edinburgh-Dundee	59¼ "	1 " 0 "	59.2
Dundee-Aberdeen	71¼ "	1 " 17 "	55.6

The York-Newcastle run on the best night was equalled on one other occasion, if not twice, during the same month.

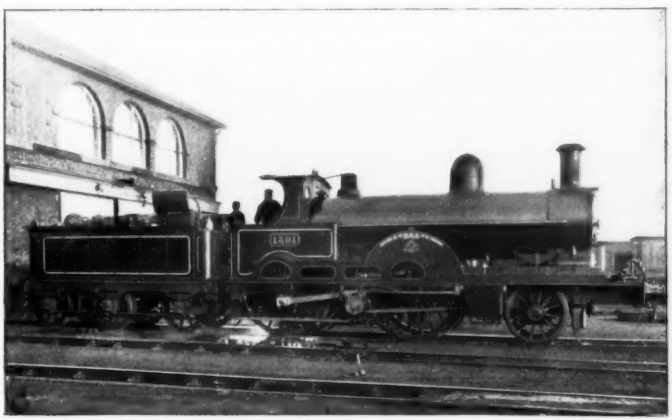
On the West Coast the engines used were: London and North Western, Mr. Webb's 7-foot compounds (cylinders 14 and 30×24)

to Crewe, and his coupled 6 feet 6 inches (cylinders 17×24) thence to Carlisle; Caledonian, Mr. Drummond's or Mr. Lambie's coupled 6 feet 6 inches (cylinders 18×26) from Carlisle to Aberdeen.

On the East Coast, the Great Northern employed Mr. Stirling's singles 8 feet 1 inch (cylinders 18½×28) to York; the North Eastern, Mr. Worsdell's coupled 7 feet 1 inch (cylinders 19×26) York to Edinburgh; the North British, Mr. Holmes's coupled 6 feet 6 inches (cylinders 18×26) Edinburgh to Aberdeen.

Maximum speeds of 85.7 miles an hour were attained on the West Coast by the London and North Western and Caledonian coupled 6 feet 6 inches, and on the East Coast by the North Eastern 7-foot coupled. The other engines, however, do not appear to have been pressed to their utmost capacity.

Early in 1897 a curious series of speed trials took place. The proceeding was virtually forced on the North British Railway, a line not usually distinguished for exceptional speed, by the culmination of its long-standing dispute with the North Eastern company as to the working of the line from Berwick to Edinburgh. This length of 57½ miles had been worked, up to that date, by the North Eastern engines, so far as the through Anglo-Scottish expresses were concerned, owing to considerations of convenience, the North British paying for the service of the engines. But, under new management, the North British, desiring to terminate this arrangement, gave notice to the North Eastern that, at the expiration of January, 1897, of the old agreement, it would not be renewed on the same terms, but that the



LONDON AND NORTH WESTERN "TEUTONIC," NO. 1301.
Compound, cylinders 14 and 30x24; driving wheels 7 ft. 1 in.; by F. W. Webb.

North British company would work all the through trains on its own line. The North Eastern authorities contended that, having statutory running powers as far as Edinburgh, they had a right to insist on continuing to work the trains.

The rights of the case are still under litigation, being now before the *eighth* court that has adjudicated on the matter. But the North British authorities positively declared that they would not permit the North Eastern engines to work the through expresses after the expiration of the old agreement, and arrangements were made for changing locomotives at Berwick.

Now, this was a simple enough matter as regarded the expresses which stopped regularly at Berwick, such as the "Flying Scotchman" and the "Corridor Diner." The time allowed was ample for the change. But two of the night expresses "down," and one "up," were timed to run past Berwick without stopping, the former making the long run from Newcastle to Edinburgh, 124½ miles, in 2 hours 23 minutes, or at the average rate of 52.2 miles an hour. It was contended by the North Eastern company that this could not be done over a somewhat heavy road, if the trains were delayed at Berwick. The North British authorities replied that it could and should and would be done. They pledged themselves that no time should be lost by *their* engines, but that, if "the North Eastern engines delivered the train punctually at Berwick, the North British engine should ensure its punctual arrival at Edinburgh." And so a "match against time" was virtually entered upon.

LONDON AND SOUTH WESTERN NO. 686.
Cylinders 19x26; driving wheels 7 ft. 1 in.; by W. Adams.

NORTH BRITISH RAILWAY NO. 634.
Cylinders 18x26; driving wheels 6 ft. 6 in.; by M. Holmes.

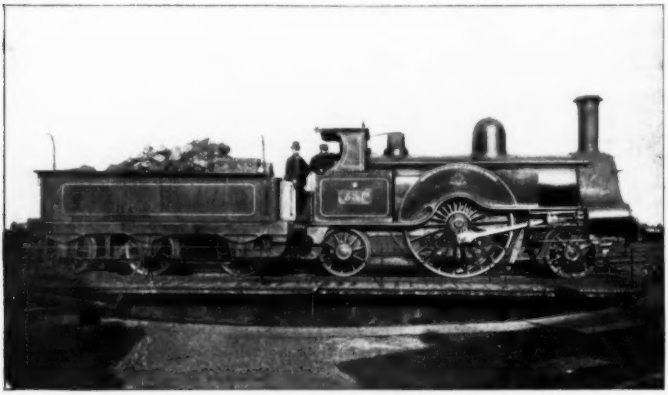
The task set was to run the 57½ miles from start to stop in 63 minutes, about half the distance being up-hill. The journey began with a climb to Grant's House Summit, 17 miles, mostly at 1 in 190 and 1 in 200, with a short break about midway. Then came a 5-mile drop at 1 in 96, then an easier descent of 6 miles to Dunbar, followed by short alternate rises and falls, and concluding with a steep rise of 1 in 78 into Edinburgh.

Although it was found by experiment that one of Mr. Holmes's coupled engines 6 feet 6 inches (cylinders 18 × 26) could easily keep time,—one, indeed, running the heavier opposite journey, with 220 tons, in a minute less time,—as the company was upon honour to maintain absolute punctuality, an assistant engine was always used on these particular trains, in anticipation of any slight mishap to the train-engine which might prevent a punctual arrival. As a result, not only was the run invariably made within the booked time, but on several occasions it was done in 5 or more minutes under time. In three instances, when I tested it, and when a special "spurt" was made, the times were respectively 57 minutes 49 seconds, 57 minutes 21 seconds, and 56 minutes 40 seconds. Down the falling grades toward Dunbar speeds of 80 to 85 miles an hour were attained, and the running was perfect in its steadiness.

On the London and North Western Railway, on January 5, 1862, a special train conveying some despatches relative to the "Trent" affair was taken from Holyhead to London, 264 miles in 5 hours, with

one midway stop at Stafford to change engines. The first run was made from Holyhead to Stafford, 130½ miles, in 2 hours 25 minutes, or at the average rate of 54 miles an hour, by the engine "Watt," No. 224, one of Mr. J. Ramsbottom's "Lady of the Lake" class, having single driving-wheels of 7 feet 6 inches and cylinders 16 × 24. This performance, both for average speed and for length of uninterrupted run, remained for many years unbeaten.

On December 20, 1895, the Great Western Company ran a special train from Plymouth to London to prove that arriving mails could be conveyed more quickly by that route than *via* Liverpool. The journey from Plymouth to London was made in 4 hours 27 minutes, including stoppages. The run from Exeter to Bristol, 75½ miles, was done in 73 minutes, or at the average rate of 62.1 miles an hour; the run from Bristol to London, 118½ miles, occupied 116 minutes, a



LONDON AND NORTH WESTERN "LADY OF THE LAKE."

Cylinders 16x24; driving wheels 7 ft. 6 in.; by J. Ramsbottom. One of the class which ran the special with "Trent" dispatches from Holyhead to London.

rate of 61.3 miles an hour. The engines used from Exeter to London were Mr. Dean's single-wheelers 7 feet 8 inches. The load was about 120 tons.

I have summed up briefly the circumstances and results of the most notable speed-trials on British railways. In doing so, I have attempted no comparison with the achievements of other countries. Those can speak for themselves. But I decline absolutely to believe that an ultimatum has been reached, in respect of possible speed, on either side of the Atlantic.

With the exception of the large picture of No. 116, Midland Railway, the illustrations of this article are taken from photographs published by F. Moore, 9, South place, London, E. C. All loads referred to are exclusive of engine and tender.

THE STEAM ENGINE AND THE DYNAMO—A CHAPTER IN EVOLUTION.

By Charles T. Child.

THERE have been no other industrial developments in the history of civilization so rapid and complete as those of the electric light and the electric railway. It is difficult to realize that only twenty-two years have elapsed since the dynamo machine made its first appearance and the electric light began to be talked about as a commercial possibility. No one could have then imagined the stimulus that its development would give to the art of engine building, and the problems that its increasing use would set for the mechanical engineer as well as for the electrician.

When the first Gramme and Siemens dynamos made their appearance, they were products of the instrument-maker rather than of the engineer. Practically nothing was then known of the laws of the magnetic circuit, or of the principles that underlay the correct design of electric generators. The consequence was that attempts to build large machines only demonstrated the necessity for further experience and greater knowledge, while the applications of the current were then so limited that there was but little occasion for the construction of electrical generators of large size.

It was not until after the Centennial exposition that the electric light was introduced on a practical and commercial scale. In the year 1877 the Jablochkoff candle was exploited in Paris and London as a practical illuminant, and the favour with which the new light was received proved a powerful stimulus to the growth of the infant art. By the middle of 1879 the incandescent light was introduced, and from that year the industry of electric lighting may be said to date.

The dynamos of that period were small, high-speed machines, generally of poor mechanical construction, savouring more of the laboratory than of the engineer's shop. The early arc-lighting machines of the Brush, Thomson-Houston, Gramme, and Weston types were limited both by mechanical and by electrical conditions to units of small size, capable of maintaining but few lights and demanding no very considerable power for their operation. When installed, usually in factories or workshops, or in some other place where power was used, they were generally belted to any convenient shaft, and allowed to regulate or not, very much as they pleased. With the arc machines accurate regulation of the speed was not so vitally necessary as it was soon seen to be for the later incandescent light machines; so the

general introduction of arc lighting made no demands upon the steam engineer that could not be easily met with the appliances then at hand. It is in connection with the development of the incandescent light that the problems of close regulation, high efficiency, and increased speed were attacked and solved, and the steam engine of to-day evolved from its predecessors of twenty years ago.

Probably the greatest improvement in steam engines since the days of Watt was that introduced by Sickels in 1841. This consisted of an independent "detachable" valve gear, so arranged that the steam which entered the cylinder and followed the piston from the beginning of its stroke was sharply cut off, at a moment determined by the governor, and permitted to work expansively through the rest of the stroke. The Corliss valve gear, a similar cut-off gear invented some years later, found great favour, and at the time of the Centennial it, or some of its modifications, was in almost universal use on engines of large power. The great majority of stationary engines of small and moderate size were, however, of the plain slide-valve throttling-governor variety, worked non-condensing. The ball governor, much as Watt left it, was still in almost universal use, though the loaded governor had found vogue among makers of Corliss-type engines, on account of its nearer approach to isochronism and its greater sensitiveness.

The high speeds of the early types of dynamos necessitated elaborate countershafting and belting for their connection to the prime mover, and the serious losses of power entailed by transmissions of this character soon attracted the attention of engineers. Almost from the first the dynamo had shown a remarkable efficiency, and, with the advent of the central station for the distribution of electric light, and the really serious study of the economic side of the subject thus brought about, it became evident that either the engine speeds must be increased or the dynamo speeds lowered. With the electrical machinery any great reduction of the speed seemed then a virtual impossibility. It was argued that, from its very nature, the dynamo was a high-speed machine. Its output was directly proportional to its speed, and considerations of first cost demanded that it be driven to its utmost capacity. The same argument, as far as the relation between first cost, speed, and output was concerned, applied equally well to the engine, and it was natural that the first efforts to more closely accommodate the driving and driven mechanisms to each other should be in the direction of increased engine speeds. So long, however, as arc lighting monopolized the field, there was no very active effort made to change the prevailing state of things, since the dynamos rarely exceeded a capacity of thirty or forty horse-power each, and the large number of them required in a station of any

magnitude necessitated countershafting and belting. The standard arrangement of an arc-light station about 1880 was a large slow-speed engine of the Corliss type, belted to one or more countershafts carrying driving pulleys for the numerous dynamos. The station was a maze of belts, but it was the best arrangement possible, and, with minor modifications, remains so to-day, in so far as series arc lighting is concerned.

The output of a dynamo is the product of the volume of the current it delivers by its tension or electrical pressure. In series arc-lighting machines the volume of current is kept approximately constant, the tension increasing with the number of lamps operated. When it is attempted to construct machines of large size to feed many lamps, the tension rises to such a degree that a limit is soon reached beyond which difficulties of insulation and the dangerous nature of the circuits prohibit extension. The largest single-circuit series arc machines absorb only about fifty horse-power, while none of the later types have yet been constructed of much more than twice this size.

With the dynamo for incandescent lighting, whether it be of the alternating or direct-current variety, and with the generator for electric railway currents, this limit of size does not exist. In them the tension is maintained as nearly constant as possible, while the volume of current delivered and the power absorbed vary with the demands of the working circuit. There is, consequently, no limit imposed by electrical considerations to their size and power. This was recognized at an early date, and with it the great improvement in efficiency and economy that would result from the construction of large machines to supply electricity from central stations. Unfortunately the total incompetence of the steam engine to perform the severe duty demanded of it by this type of machine was also but too soon evident.

For incandescent lighting an absolute essential is the maintenance of a constant electrical tension upon the supply mains. The smallest variations produce an unpleasant flickering of the light, while larger ones result in disastrous shortening of the life of lamps and unpleasantly significant figures in the balance sheet. Steady tension under varying loads means steady speed of the dynamo, and, since any variation of the speed produces a greater corresponding variation of the tension and a still greater variation in the light from incandescent lamps, the steadiness of the engine speed must be almost absolute to insure commercially-successful operation. It is easy to see what a problem confronted engineers suddenly called upon to cope with these new conditions and armed with no better appliance than the ball governor of Watt.

The efficiency of the large independent valve gear engines, in use

at the time when the extension of central-station lighting gave rise to the new demand for perfect speed control, left very little to be desired. The most obvious improvements to be sought were the increase of engine speeds, the shortening of the stroke to diminish cylinder condensation, and the elevation of working pressures. Evidently, other things being equal, a high-speed engine will more quickly accommodate itself to a changing load than one working at slower speed, while the effectiveness of a fly-wheel in smoothing out the varying torque due to reciprocating piston motion increases rapidly with the speed of rotation. It seemed, therefore, that higher speeds would not only improve the efficiencies of existing types to some degree, but also assist materially in the solution of the difficult problem of regulation.

At the outset of the movement for high speeds it was recognized that the independent valve gears then in use would not accommodate themselves to very fast running. Some form of positive valve gear must be used, and the high efficiency of the detachable gear must be sacrificed to the exigencies of regulation and speed. Precedents could not be considered in the design of an engine which deliberately set out to accomplish what was then thought to be the impossible.

The first high-speed automatic engine for electric lighting, the invention of Messrs. Porter and Allen, was a very radical departure from the standard type in many ways. The quick-acting induction-valve of the Corliss type was replaced by a variety of piston valve, while the older type of separate exhaust valves was retained; but the main departure, aside from the speed of running, was the method of governing. An eccentric on the main shaft of the engine operated the exhaust valves, and also a link into which the induction-valve rod was geared. The governor, a weighted-ball affair, varied the position of the attachment of the rod to the link, and thus changed the point of cut-off.

Higher speed meant the increase of the various stresses incident to the starting and stopping of the reciprocating parts, increased friction, much greater need for rigidity in the bed of the engine, and more accurate alignment. It is doubtful if the great speeds successfully attained in the early electric-light engines would have been possible, had it not been for the great improvements in nearly all forms of machine tools that had been lately perfected.

Strength, as well as accuracy of workmanship, was an essential feature in the construction of engines that were to run at three hundred revolutions per minute, or more. At that speed the piston, piston-rod, and cross-head must be started from rest, accelerated up to full speed, and stopped with the least possible shock, no less than ten times a second.

The shorter stroke of such engines enabled their designers to make them very compact, and, by shortening the bed, to greatly improve upon the rigidity of older types. A double economy in space was secured at the same time, since the shorter stroke diminished the length of the engine frame, while the increased speed multiplied the power output proportionately.

For about two years the pioneer high-speed engine was alone in the field, an object of cavil for the older engineers who believed in slow piston speeds and the quick cut-off and "square-cornered" indicator diagram of the detachable valve gear engine. When, however, its success in driving electric-light machinery became evident, and the demand for accurate-governing, fast-running engines became pressing, new types began to appear from all sides. Attached to one of the first of these was a shaft governor, perhaps the next greatest advance in the art of engine building after the detachable valve gear and automatic cut-off regulation. This governor operates by shifting the eccentric with reference to the shaft, so that the throw is increased or diminished, thus varying the cut-off. Generally these engines have but one valve, and their simplicity and excellence of design combined to make them admirably fitted for the work they were called upon to perform. The problem of regulation had been solved, and at the same time speeds so increased that the dynamo and engine could be belted directed, or even mechanically coupled together if the dynamo was very large. As early as 1883 an incandescent light dynamo of considerable size, directly coupled to an engine running at 350 revolutions per minute, was exhibited, and combinations of this character were used in the early central stations in New York. The engine had been improved out of all resemblance to its former self, and its speed trebled or quadrupled, but the dynamo obstinately remained a high-speed machine.

In 1888 the electric street railway opened a new field to builders of engines and dynamos. The requirements of this service were even more exacting than those of electric lighting, for the variations in the load far exceeded those of the illuminating circuits both in suddenness and magnitude. Both engine and dynamo were subjected to stresses that had not been encountered before, and both suffered. It was seen that engines for railway service must be made heavier and stronger, that their design must be modified to conform to the exigencies of the new service, and that a large fly-wheel was able to tide over many of the brief overloads common in railway work. The dynamo was by no means so well adapted to the severe requirements of electric-railway work as the engine. Practically all dynamos, at the period referred to, had smooth-core armatures of the cylinder type, though

some were built with Gramme ring armatures. Only one commercial machine had a toothed-core armature. The Gramme rings were deficient in mechanical strength and expensive to wind, besides being organically liable to disastrous ailments; so they soon disappeared. The smooth-core cylinder armature was cheap and simple, but it possessed some inherent defects whose removal marked one of the longest steps in the progress of dynamo development. The first improvement to be generally introduced was a system of winding that used machine-made coils instead of hand-winding. The attachment of the coils to the armature core was generally by wooden or metallic driving keys, and through these the whole power of the engine was necessarily transmitted. A heavy short-circuit has been known to strip every wire loose from the core of a smooth-bodied armature. Over the outside of the mass of wires forming the winding were binding bands of other wires, the whole forming a structure that was mechanically frail and not easy to insulate against the electrical pressures employed in railway work.

But, aside from these mechanical deficiencies of the older type of armatures, there was a grave electrical difficulty in the necessarily wide gap between the iron of the armature core and the stationary pole-pieces of the machine. In this space were included the windings and the clearance needed for safety between them and the pole-faces, in all a considerable layer of highly-resisting medium through which the magnetic induction of the fields must penetrate. The remedy for both the magnetic and mechanical troubles was obvious, and was quickly applied. Dynamos appeared having their armature windings deeply sunk in slots or tunnels in the metal of the armature core, leaving the surface of the armature clear of wires, and enabling it to approach the pole faces as closely as mechanical safety of running would permit. At once the speed of rotation was also reduced, as, in the far stronger magnetic field secured in this way, a less peripheral velocity of the armature windings was needed to secure the same electrical results. The new construction, in addition to greatly enhancing the mechanical strength of the armature, had also the advantage of permitting better insulation of the windings, and thus almost entirely obviated their accidental destruction.

As the stations for electrical generation grew large, the size of dynamos increased in proportion. The larger the machine, the less its first cost proportionately to its output, and the less house-room requisite for its installation. The increase in size naturally meant a decrease in speed, while the multipolar construction adopted for the largest dynamos involved a still further lowering of the necessary revolution rate. It is now evident that the dynamo could be made,

in large sizes, for a normally slower speed than that of the prevalent type of dynamo-driving engine.

When the change to high speeds in engines was made, there had been a sacrifice of economical steam consumption to secure the increased velocities and quicker regulation. The single-valve automatic engine was a signal success under certain conditions, and wonderfully well adapted for use in small units, but it was not efficient. Neither compounding or the use of a condenser would make it as economical as the Corliss type under similar conditions, especially after the latter had been improved by the substitution of spring-driven cut-off gear for the old gravity type, and set to work at somewhat higher speeds than formerly. There was now a wide range of speeds at which both engines and dynamos could be efficiently operated, and the direct coupling together of the two machines began to be the rule rather than the exception.

With the growth of systems and stations came also an increase or confidence in the good qualities of large dynamos and engines, and an increasing tendency to adopt very large units. Engines of a marine type, having vertical cylinders, direct-coupled to large generators, came into vogue in England and Germany, and American engineers were not slow to see the excellence of this arrangement for very large units. A recent example of a combination of this sort is used for the generation of alternating currents for lighting purposes. The engine part is a two-cylinder vertical cross-compound of 2,000 nominal h. p. The dynamo has an output of 350 amperes at 2,400 volts on each side of its two-phase circuit, and furnishes current for lighting 30,000 incandescent lamps of sixteen candle-power each. The combined machine, engine, and dynamo, each of whose parts was designed with reference to the other and to their efficient action when operating together, occupies a space of 33 by 28 feet, and is nearly 23 feet high. There is no fly-wheel, the 75,000-pound armature taking its place. The speed is 116 revolutions per minute.

This combination is typical of the best modern central-station practise. In isolated plants, or where there is a demand for smaller generating units, the high-speed automatic engine direct-coupled to an appropriate dynamo enjoys much favour. For train lighting, yacht lighting, and other isolated installations of very small size, direct-connected units operating at speeds as high as 600 revolutions per minute have been successfully used. On the other hand, where conditions require it, dynamos are built for very low speeds, one recent water-power installation in Switzerland using dynamos of large size and power running at only 28½ revolutions per minute.

The cognate development of the dynamo and its driving engine

has thus been directly responsible for the appearance of the high-speed automatic cut-off engine, and its wide use during the period of experiment and study in which the true laws of the dynamo were discovered. With the coming of greater experience and the demand for larger units, the less efficient high-speed engine has been forced to give place to its predecessor, the detachable valve gear engine, but the latter has been profoundly modified as the result of the experience gained during the years while the automatic type held undisputed sway. The shaft governor, the piston valve, and the crank-disc are some of the features of the automatic type that survive in the modern, large-sized, dynamo-driving, detachable-gear engine.

A new departure, however, in steam engineering, the steam turbine, promises to drive dynamo designers to the consideration of the very highest speeds for their machines. The remarkable efficiency of the steam impulse wheel, its extraordinary simplicity, and the high output of power per unit of weight secured by its use, make it the ideal machine for the conversion of thermal into mechanical energy and for dynamo driving, save for the one almost fatal difficulty of its enormous and unmanageable speed of rotation. The wheel rotates at great speeds, often as high as 30,000 revolutions per minute. So far the unmanageable velocities encountered have forbidden the commercial extension of the method, though some combinations of steam turbine and dynamo are successfully working under commercial conditions. Hitherto no attempt has been made to design a dynamo for direct operation at the speed of the turbine, but the effort has been to reduce the speed, either by gearing or directly, to that of the present types of dynamos. The analogy of the case of dynamo and reciprocating engine twenty years ago seems to point to some compromise method. Certainly gearing will never be tolerated, so long as there is the least hope of directly reducing the speed of the steam turbine. There appear to be good grounds for thinking that compounding offers a solution of the difficulty, and that speeds as low as 2,500 revolutions per minute may be had directly from a multiple-wheel, multiple-expansion turbine. It is not, therefore, beyond the bounds of possibility that our future central stations will contain no reciprocating machinery larger than a boiler feed pump.

There seems to be no limit in sight at which the growth in size of the dynamo and engine combination must cease. Marine types of engines of great efficiency are now in use on the better class of passenger steamships, in units as large as 15,000 h. p. While the largest dynamos now at work are only of 5,000 h. p., it is safe to say that there is no reason whatever why they cannot be made to-day three or four times as large, should there be any occasion for their construction.

THE GAS ENGINE IN AMERICAN PRACTICE.

By George Richmond.

EUROPEAN writers usually dismiss the subject of American gas engines with a few brief paragraphs, and the inference that little has been contributed by this country to the development of the gas engine is justified, to a certain extent, by the facts. Until recently an account of American engines would have been merely a repetition of the description of European types, and not the most modern types at that.

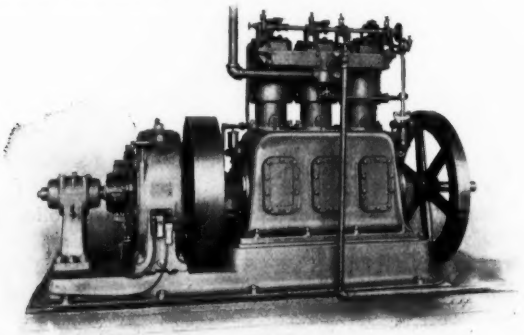
The slow growth of this industry in the United States has sometimes been attributed to want of enterprise on the part of those having the Otto patents, which for a time practically controlled the business. But we do not find the same activity as in Europe in designing substitutes for the Otto Cycle, nor did any of the imported substitutes obtain any foothold in this country; so that we must look for other reasons.

The most important of these are: first, the lesser number of small industries in this country, requiring a moderate amount of power; second, the greater cheapness of coal, together with the higher price of gas, both actually and relatively. To these causes may be added the higher rate of interest in America, rendering the investment in a high-priced gas engine a serious charge upon a business. That this latter consideration was really a potent factor in retarding the growth of the gas-engine business is shown by the fact that, immediately after the expiration of the Otto patent, the market was flooded with engines whose chief characteristic was cheapness. This cheapness was effected in part by simplification of details, more or less successful, but chiefly by reduction in strength and over-rating of capacity. A healthy reaction, however, is distinctly noticeable, and it is reasonably certain that in a short time high-grade gas engines will be sold in America at less per horse power than in any country in the world. And this result will be brought about by factory methods of manufacture in quantities, and excellence of design and workmanship, rendering possible high rotative speeds,—not by niggardliness in parts and proportions.

Had the gas-engine business continued to be confined to the manufacture of very small engines, the electrical distribution of power would have proved a very serious rival. As it is, however, electricity seems destined to prove a most valuable ally, which will lift the gas engine into serious rivalry with the steam engine itself.

It has been shown that in practice a given volume of illuminating

gas employed in a gas engine to generate electricity will furnish nearly twice as much light as if burned in the ordinary manner, and, although the incandescent gas burner may to a certain extent offset this in towns, the internal combustion engine, using oil or gasoline, will remain the cheapest and simplest means of producing electricity for country houses, village communities, etc.



WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY'S 3-CYLINDER GAS ENGINE AND DYNAMO.

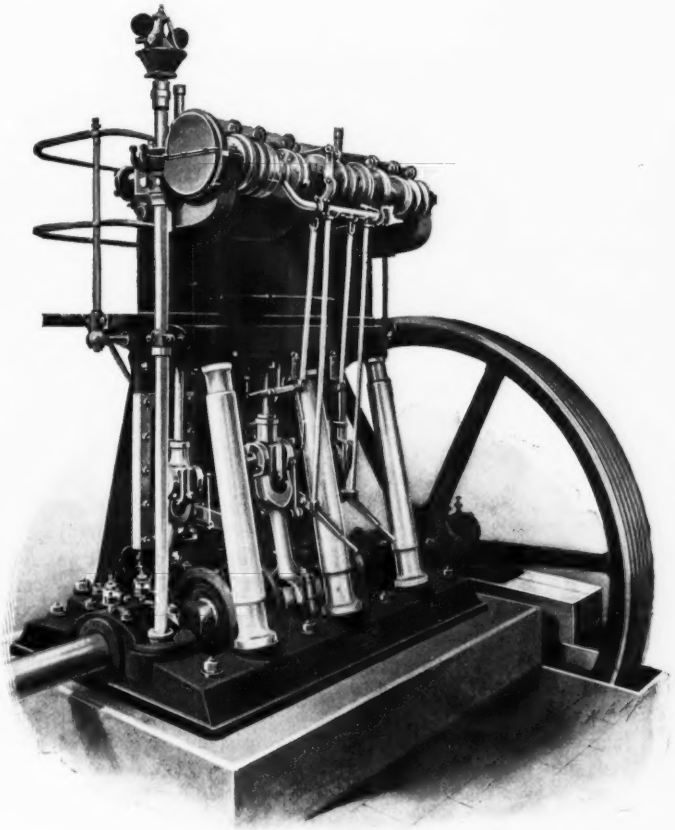
The development of electrical industries, on the other hand, has caused a demand for power in so enormous quantities that economy of fuel becomes a more and more important consideration.

When reliable gas engines of 1,000 h. p. and upwards can be operated with from half to three-quarters of a pound of coal per horse power per hour, we may look for the gradual displacement of the steam engine in power houses. We are assured that the building of such engines is only a question of time, and that the greatest present obstacle is the absence of a suitable producer adapted to furnishing gas from the cheaper grades of coal. The fact that large and wealthy firms are devoting considerable energy and lavish expenditure to this work is an evidence of confidence in the ultimate result of their efforts.

In the shops of the Westinghouse Machine Co., a gas engine of 750 h. p. convertible into 1,000 h. p. may be seen, and it is understood that the company is preparing to build still larger sizes. It is said, also, that Krupp is to build a 1,000-h. p. Diesel engine for the Paris Exposition of 1900.

The Brayton engine is perhaps the best example of an internal combustion engine of distinctly American origin, although it is claimed that Sir Wm. Siemens proposed the same cycle at a much earlier date. Brayton, however, was the first to produce a workable

oil engine of the type in which the air is compressed in a separate cylinder and combines with the oil in a working cylinder, the intention being to continue the combustion at a constant pressure during a portion of the working stroke, after which the supply of oil is cut off and expansion continues during the remainder of the stroke. The governing is effected by varying the point of cut-off of the oil, and the diagram produced is very similar to that of a steam engine operating with varying cut-off.



150-H. P. 3-CYLINDER DIESEL MOTOR.

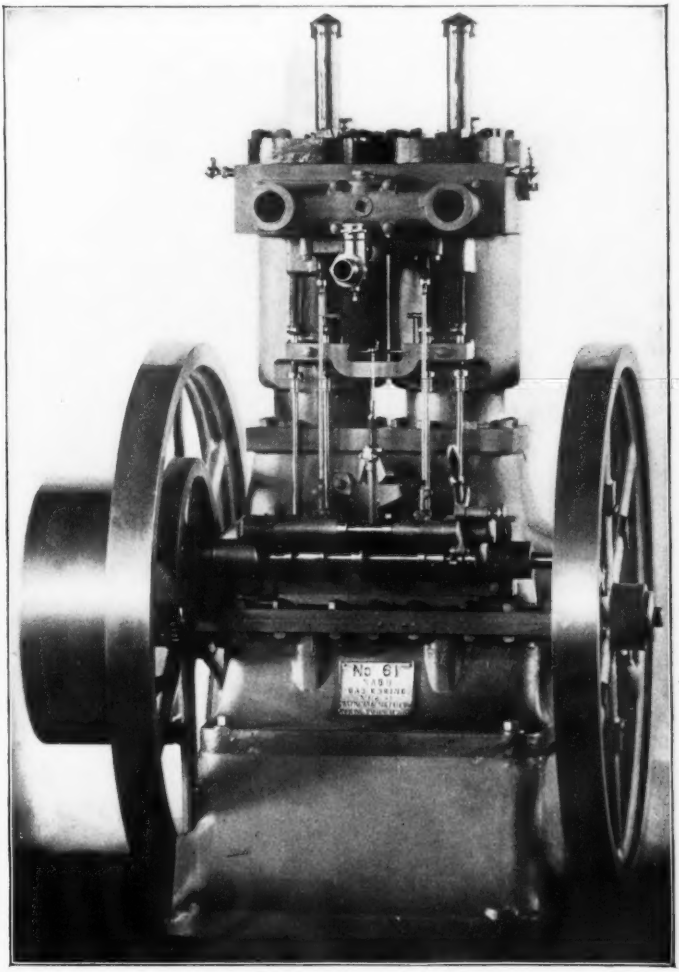
THE KANE-PENNINGTON 4-H. P. MARINE ENGINE. WEIGHT 50 LBS.

It is interesting to note that the Diesel Rational Heat Motor, when using liquid fuel, operates in precisely the same manner as that of Brayton, except that it aims to obtain combustion at a constant temperature instead of at constant pressure. In this respect the cycle of the Diesel engine is theoretically inferior to that of Brayton. Diesel, however, developed the idea to a brilliant success, while Brayton's engine was a failure.

The cause of Brayton's failure lay in the means of ignition; Diesel avoids this by increasing the compression to the point at which ignition is automatic.

It is to be feared that at the present time Europeans associate the idea of American gas-engine design with the Kane-Pennington engine. Our English cousins have paid a very large price for the privilege of controlling the manufacture of this remarkable engine, and are interested in certain "foreign syndicates" for the granting of like privileges to other nations. It would be interesting to collect the expert reports and technical-journal descriptions of this engine. There is, indeed, about it, a democratic simplicity and an ignoring of conventional rules of construction that are truly characteristic; moreover, the boldness of the conception of the "ripening and cooling" spark was hardly less startling than the seriousness with which it was discussed. To show that this is not all that the United States have contributed to gas-engine design, a number of cuts of engines are given with this paper. They have been selected on account of the novel and distinctly American treatment of the subject. As there are more than fifty firms in America engaged in building gas engines, it was necessary to select the illustrations on a somewhat narrow basis, and all engines of the standard European design have been excluded.

It is not asserted that these are the best gas engines built in America, or even that the boxed-in multiple-cylinder type will eventually prove the most satisfactory. It is the type, however, which at present commends itself to the most enterprising American firms, and it will be interesting to watch its development.

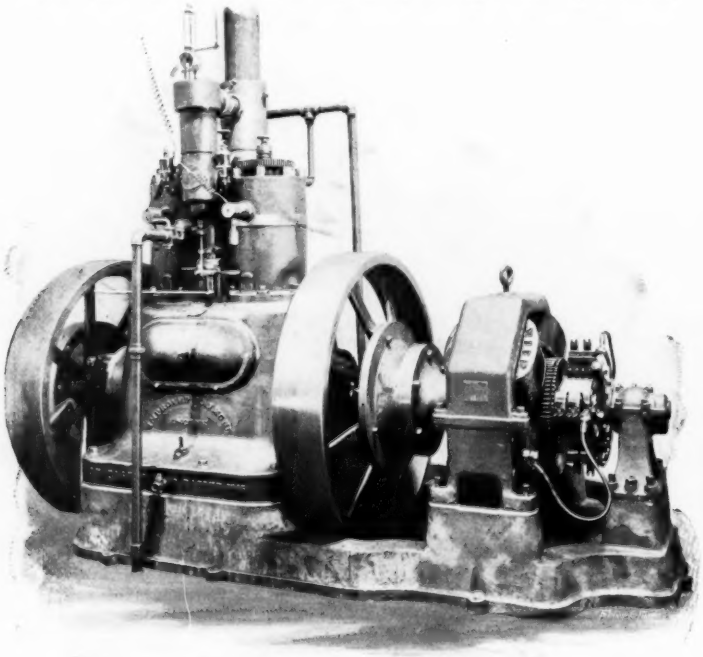


15-H. P. NASH GAS ENGINE WITH INCANDESCENT-TUBE IGNITER.

About the time the United States exported the Kane-Pennington engine to Europe, the Gardie engine was brought over from there, and had a brief and inglorious career under the Americanized name of the "Bates Triple Thermic Motor." In this case, as an example

of the uncertainty and injustice of fate, an extremely ingenious engine the theory of which, together with the working details, had been elaborated with the most careful and intelligent industry, was allowed to drop into undeserved oblivion as an instrument of a stock-jobbing fiasco. It reached the United States loaded up with too ingenious and complex mechanism, and at first sight seemed a proper object for simplification and development by American mechanics. Gardie, in his patent specification, describes his engine with remarkable clearness as follows:

"My new engine operates on the following principle. The gas issuing from a special generator is conducted to a compressor. At the same time air is compressed in another compressor. By reason of their compression the gas and the air are heated to about 200° Centigrade. The gas and the air thus compressed are further heated to about 400° by being passed separately through heat-regenerators,

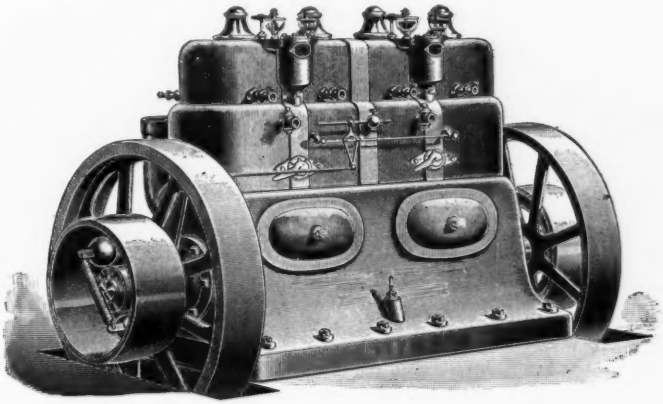


J. I. CASE T. M. COMPANY'S 2-CYLINDER GAS ENGINE, 30-H. P., DIRECT-CONNECTED TO DYNAMO.

after which they are conducted to the motor-cylinders, being discharged thereinto in thin jets or layers, the jets of gas and air being alternated. In the motor-cylinders the gaseous mixture is caused to burn by coming into contact with an igniter, and, by reason of the combustion, the temperature rises to about 1,500°, the expansion of the gas forcing the pistons to move in the cylinders. By reason of the expansion, the temperature falls, and the spent gases, still hot, are discharged from the cylinders and utilized in the regenerators for heating the gas and the air, which are on their way to the motor-cylinders."

Just as American engineers were beginning to feel that they were catching up, and had nicely recovered from the temporary shock of the Bates Triple Thermic motor and its five-million-dollar company, a new record-breaking gas engine was presented to them in the form of the Diesel Rational Heat Motor. At present a company with $1,000,000 capital is acting as advance agent, and by the time this is read an engine will be in operation in the United States. If it is handled there with the consummate business ability that has been shown in Europe, its claims cannot fail to attract the earnest attention of all engaged in the gas-engine business.

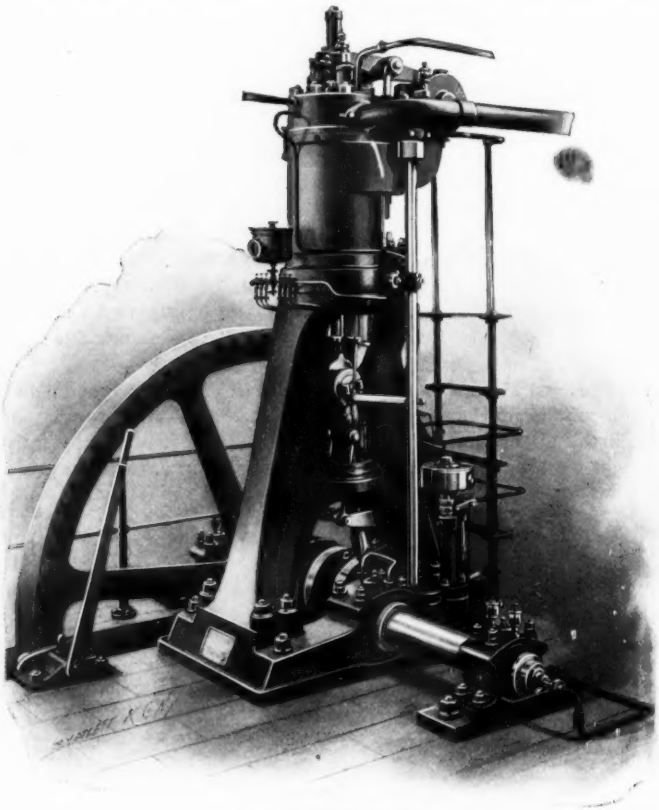
The Diesel Motor belongs to that class of which the Brayton and Gardie motors are the most conspicuous examples,—namely, that in which the air and fuel are separately compressed and subsequently brought together for ignition. In the Diesel motor, however, pressures are used which have never been attempted, and it is indeed a tri-



J. I. CASE T. M. COMPANY'S 4-CYLINDER 80-H. P. GAS ENGINE.

umph of shop-work that a gas engine compressing to 35 atmospheres should operate with a mechanical efficiency of 75 per cent.,—the result shown by the test of Prof. Schroeder when the engine was running at full load.

As was to be expected, the use of these high pressures, under me-



20-H. P. DIESEL MOTOR.

chanical conditions so favorable, results in a thermic efficiency higher than has hitherto been obtained. By thermic efficiency is meant the ratio of the heat converted into work to the total heat supplied to the engine. Theory calls for an increase of thermic efficiency with increase of compression. It was the adoption of prior compression of

the charge that gave the gas engine an efficiency which justified its adoption as a commercial machine. Makers have slowly increased the compression,—with some hesitation and misgiving, but always with increase of efficiency. The table given below shows this progressive increase of compression and the accompanying increase of efficiency.

"Absolute indicated efficiency of Crossley Otto Engine of similar size, since 1882."

	Efficiency.	Pressure of compression above atmosphere.
(1) 1882–88	0.17	38 lbs per sq. in.
(2) 1888–94	0.21	66.6 " "
(3) 1894	0.25	87.5 " "

Dugald Clerk, who gives this table,* recorded in the February number of this magazine an efficiency of 30 per cent., with a compression of 95 pounds.

With a compression of more than 450 pounds to the square inch, the experimental motor of Herr Diesel has shown an efficiency of more than 34 per cent. The bold jump taken in the case of the Diesel Motor is, therefore, rather disappointing in its results. It has shown that, contrary to the opinion of conservative gas-engine experts, it is possible, with the excellent workmanship of the Augsburg Machine Co., to run an engine successfully with these high pressures. It seems, however, to confirm the opinion that the net increased efficiency so obtained is small compared with the increase of compression. The comparison, however, is not entirely just, for the reason that in the Diesel engine the compression pressure is, theoretically, the maximum pressure, which is far from being the case in the ordinary Otto engine. In the instance just quoted, where the compression amounted to 95 pounds, the maximum pressure after ignition was 310. So far, therefore, as the mechanical difficulties are concerned, the comparison should be between pressures of 310 and 450 pounds respectively.

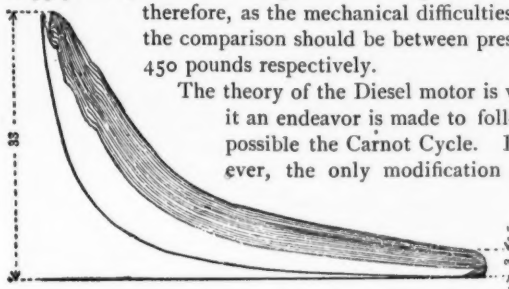
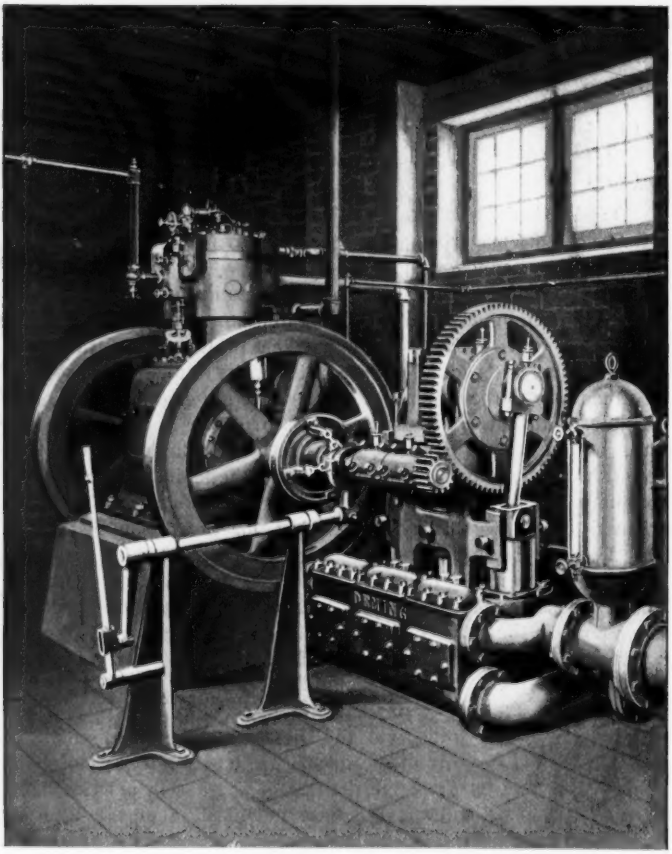


DIAGRAM OF DIESEL MOTOR UNDER VARYING LOAD.

The theory of the Diesel motor is very simple. In it an endeavor is made to follow as closely as possible the Carnot Cycle. In practice, however, the only modification of the Beau de Rochas Cycle attempted is in the period of combustion. In the Beau de

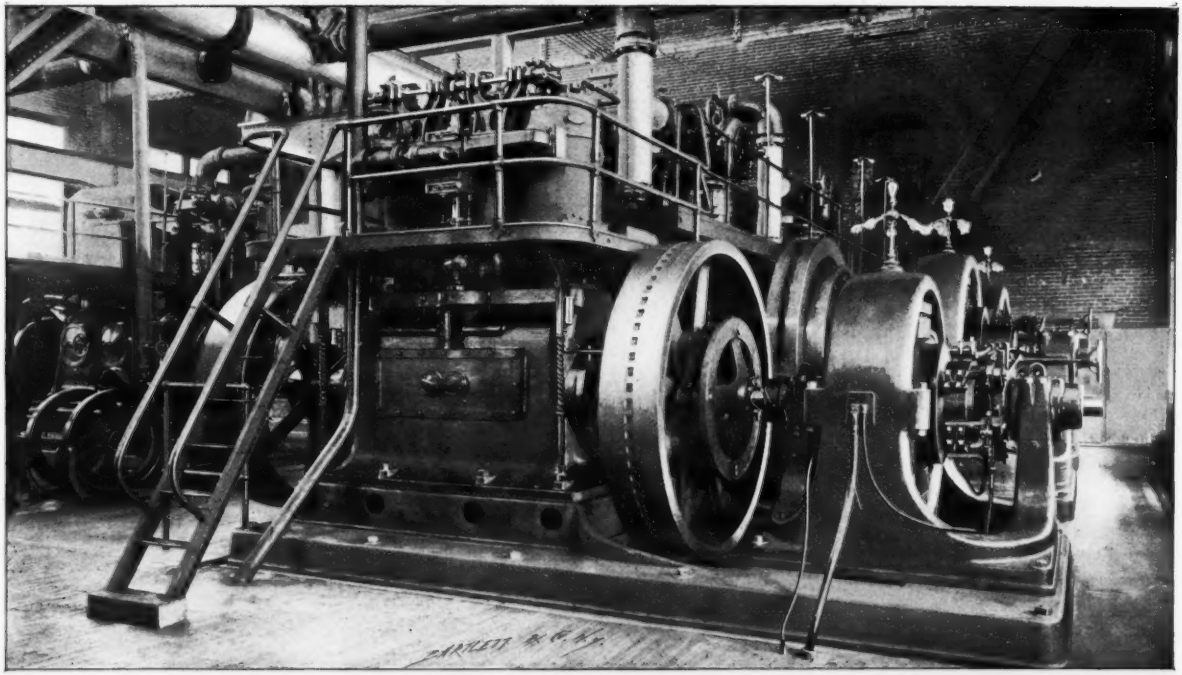
* "The Gas and Oil Engine," p. 376. Dugald Clerk. J. Wiley & Sons.

Rochas Cycle the combustion takes place at constant volume; at least, it is presumed to do so, although, as a matter of fact, about one-half of the total heat is generated at constant volume, and the remainder during the expansion of the ignited mixture. The Carnot Cycle requires

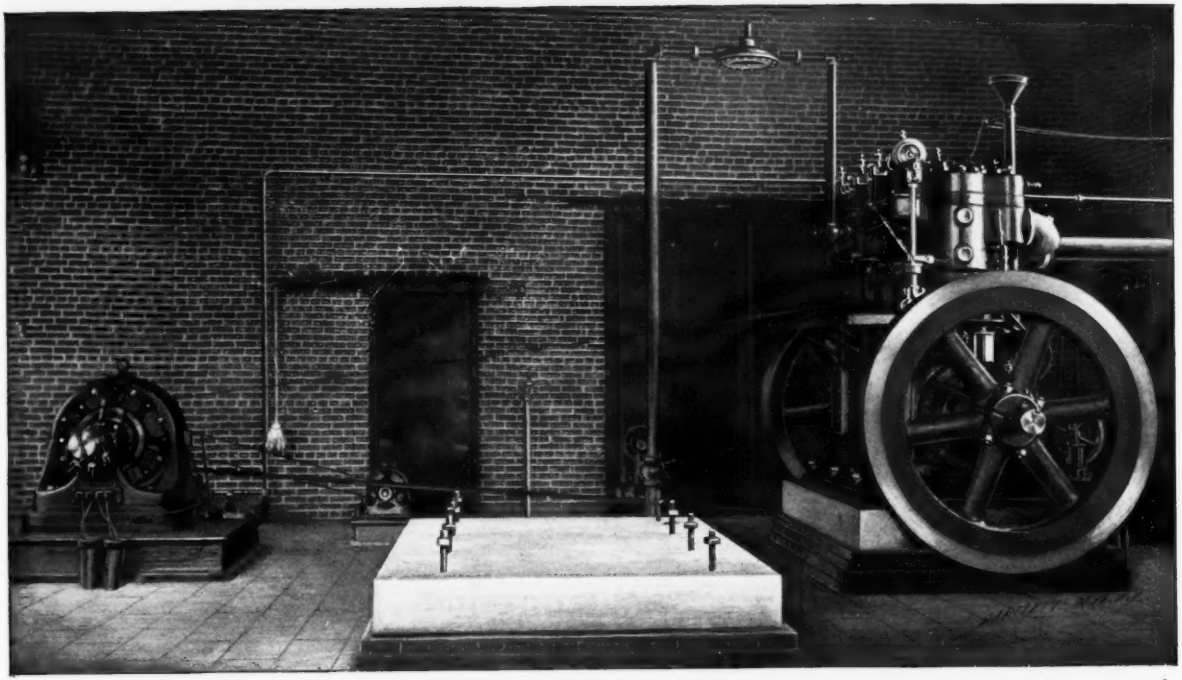


WESTINGHOUSE GAS ENGINE IN EAST PITTSBURG WATER CO.'S PUMPING PLANT.

that the heat should be supplied at constant temperature, and in the development of the Diesel motor a vast amount of ingenuity and patient experimenting have been expended on means of insuring this isothermal combustion. The air having been compressed until the

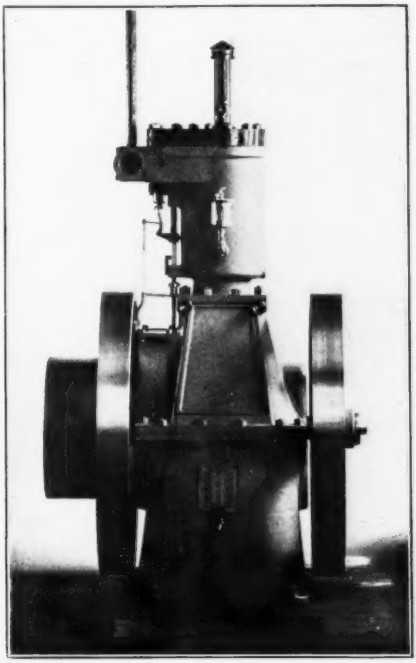


WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY'S POWER HOUSE, WITH 225-H.P. GAS ENGINE.
The 600-h. p. steam engines, directly behind the gas engine, afford an idea of comparative size.



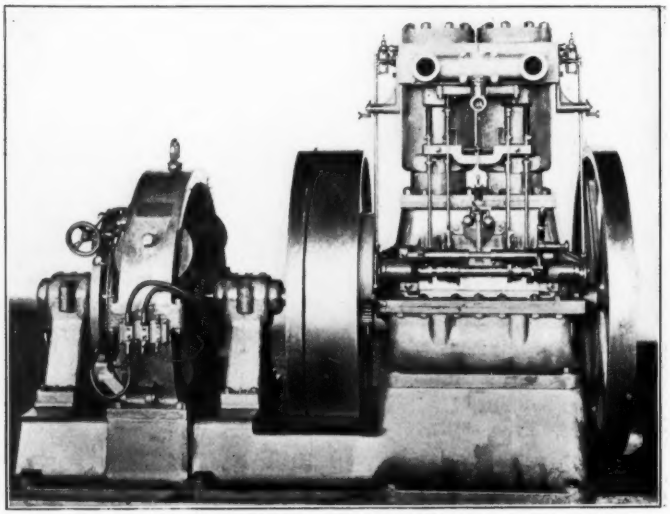
LAFAYETTE, IND., U.S.A. CENTRAL-STATION PLANT, RUN BY TWO 125-H.P. WESTINGHOUSE GAS ENGINES.

temperature due to compression is equal to, or higher than, that required for combustion, the fuel under still higher compression is fed gradually into the hot air during the first part of the expansion stroke.



SINGLE-CYLINDER NASH GAS ENGINE.

The heat generated by the resulting combustion, instead of raising the temperature, is so controlled as to balance the heat disappearing by conversion into work. Thus, during the supply of the combustible, the temperature remains the same, and, when this is cut off, the temperature falls, in consequence of the work done by adiabatic expansion. It is to this isothermal combustion that Diesel attaches the greatest importance. It is obvious that, with the most delicate and complex mechanism, it can be only approximately obtained, and the belief in its advantage appears to be based on a misconception of the doctrine of Carnot, or, rather, a misapplication of it that is not at all uncommon. Carnot enunciated the principle that temperature is the significant factor in the efficiency of any heat engine, and explained the sequence, or cycle, of operations by which to secure the maximum efficiency of an engine working between two given temperatures. The inference is frequently made that, the nearer a given cycle can be made to the Carnot cycle, the greater its possible efficiency will be, and the phraseology of the subject lends itself to this fallacy. Now, if any simple gas engine were modified by the substitution of isothermic combustion, its actual thermic efficiency would be enormously decreased, and, conversely, the isothermic expansion of the Diesel Motor Cycle is far from being its most valuable feature.



20-H.P. GAS ENGINE, NASH SYSTEM, DIRECT-CONNECTED TO RIKER DYNAMO.

After a given compression, we have the choice of three modes of combustion :

(1) at constant volume, as in the Otto, or Beau de Rochas.

(2) at constant pressure, as in Brayton's engine.

(3) at constant temperature, as in the Diesel.

These are written in the order of their efficiency, and the "Rational Heat Motor" will be most efficient as a plain gas engine.

The illustrations, as already mentioned, represent characteristic American gas engines. Examples of the British type were illustrated in the January number of this magazine, and there appears to be a reaction in its favor in the United States, which adopted the lighter, more graceful, but less substantial German design.

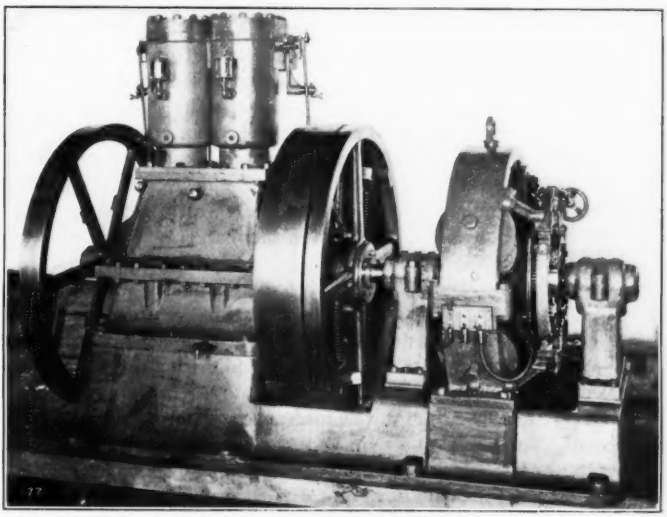
The details in each case have been worked out with great skill. For the ignition of the charge the Nash engine employs either the hot tube, or the electric spark, or both. The Westinghouse employs only the spark, but supplies each cylinder with a duplicate apparatus. This recognition of the element of uncertainty in artificial ignition emphasizes the desirability of abolishing it altogether.

The Westinghouse engine governs by throttling the charge, while maintaining a constant composition of the mixture. The result of this is that at light loads, the compression being reduced, the efficiency of the engine is reduced, as explained above, but at the same time,

there being no misfires, the speed regulation is much closer than is possible by the hit-and-miss principle. This sacrifice of efficiency to close regulation indicates the intention of applying the engine chiefly to the generation of electricity.

Several examples of direct-connected engines and dynamos are given. The Nash combination, as shown, employs a very ingenious arrangement for converting irregular into regular rotation. The engine, of which the regulation is effected by the orthodox hit and-miss principle, runs permanently faster than the dynamo with which it is connected by frictional contact. If the speed of the dynamo increases, an arrangement equivalent to a fly-wheel governor relieves the grip of the shoes and allows more slip. When the springs and counterweight are nicely adjusted, the sensitive and prompt action of this arrangement is astonishing, and it can be criticised only on the score of its excessive ingenuity.

One result of this arrangement, which appears singular until the cause is known, is the circumstance that, as more lights are put on, the brighter and steadier they burn. A little consideration will show that, the greater the load, the tighter the grip, and therefore the greater speed (and voltage) to release it; moreover, with greater load there are fewer misfires, and therefore there is less variation for the frictional connection to take care of.



20-H.P. NASH GAS ENGINE WITH DYNAMO, SHOWING FRICTIONAL CONNECTION.

The Westinghouse two-cylinder engine has a provision for distributing the shock of the explosion by means of a spring connection (as shown) between the engine and dynamo. With the three-cylinder engine, however, the necessity for a flexible coupling is believed to be obviated, and, since this type also has its moving parts well balanced, it is preferred by the Westinghouse Company.

There is an evident determination to solve the problem of "direct connection" in some form or other. In the meantime the link belt, run slack, together with a fly wheel on the dynamo, offers a solution which is effective and will not be abandoned until the various substitutes have shown that the necessary sacrifice of simplicity is warranted by the results.

So far as the writer knows, no independent tests have been made public, with the exception of one at Stevens Institute last year on a Nash engine, according to which the quantity of gas consumed per brake horse power was 17.62 cubic feet, which is equivalent to a thermic efficiency of 20.6 at brake. For starting the larger engines the Westinghouse Company employs the reservoir of compressed air, but with the addition of a very neat automatic valve arrangement, by which one cylinder is run for a few revolutions as a compressed-air engine. The Case engine introduced a rather bold method of starting by firing a cartridge of rather slow-burning powder, converting the engine for the initial stroke into a gun.

Precisely why, in the present state of the art, so much money should be spent in getting out a new gas engine is not entirely clear. One reason, probably, is that the designer generally starts out with a great contempt for what he considers the clumsy and empirical methods of the gas engineer. The first $10,000 is spent in imparting to him a few elementary ideas on the subject, the second in trying his revolutionizing modifications, the third in getting the engine to run as economically as others in the market.

Even scientific Germany does not appear to be exempt from this process. The first Diesel engine was built without a water jacket, compounding is even now being experimented with at great expense, and to these ancient and distinguished fallacies is added a third,—the isothermal combustion elaborated with a quasi-scientific and solemn minuteness intended to be admired rather than understood.

For quick returns no improvement has been made on the old combination of a fine model and a limited knowledge of the art to which it belongs, the latter being essential to enable the inventor to promise, with the force of personal conviction, the extravagant results necessary to induce capital to take the desired "flyers."

REVIEW OF THE ENGINEERING PRESS

The Efficiency of Built-Up Beams.

AMONG the papers recently presented before the American Institute of Mining Engineers is one of especial importance, by Professor Edgar Kidwell, upon the efficiency of built-up wooden beams. From the fact that the matter has been almost, if not quite, neglected, Professor Kidwell's investigation into the comparative strength of various kinds of built-up and solid beams may be considered as an original contribution to the literature of constructive engineering.

Wooden beams are likely to be used for a long time, even though iron and steel construction has become so widely extended; and the limitations naturally placed upon the sizes of single sticks make it necessary, in many cases, to build up large beams from several pieces. Until now, however, the leading authorities upon the subject have assumed that the strength of the compound structure was at least equal to that of the solid beam, ignoring the weakening effect of the joints, and disregarding the obvious differences in the various methods of keying and bolting.

The respect which technical writers have for authority is seen in the faithfulness with which they copy and re-copy from Tredgold, even so original a writer as Rankine preferring to follow the ancient precedents with apparently no attempt to verify the results by tests or comparison with practical results.

Professor Kidwell respectfully places all the previous authorities on one side, and proceeds to make new tests of the received methods of construction, as well as of some additional forms of joints, expressing the strength in the form of a percentage of the strength of a solid beam of the same dimensions loaded under the same conditions.

The results of these careful original tests show how erroneous was the old assumption that the strength of a built-up beam attained nearly or quite that of a solid one, for the investigations revealed the fact that some forms which had been considered among the best gave efficiencies as low as 60 per cent., while other forms, often more easily made, gave efficiencies as high as 90 per cent.

A still greater difference was found between the deflections of built-up beams and those of solid ones; in fact, this is frequently a matter of more importance in construction than the absolute strength of rupture.

The best form of built-up beam, according to Professor Kidwell's researches, is what is known as the "joggled" beam, with iron wedge keys, or even with wooden keys. This form is better than any of the more elaborate framed and bolted beams which have heretofore been advocated.

"It seems clear from these tests that it is practically impossible to construct a built beam which shall be as strong as a solid beam of equally good material. The writer considers that the results of the tests warrant the conclusion that the keyed or joggled beam is by far the best form, as it surpasses all others, both in strength and stiffness. Oak, hickory, hornbeam, or dogwood keys will suffice for beams constructed of white pine, spruce, or other soft woods, but iron keys should be used for hard-wood beams. Wedge-shaped driving-keys are necessary in order to secure the most efficient beams, and the keys should be of iron if the maximum stiffness is desired. In the centre of the span a space equal to about one-quarter of the length of the beam should be left free of keys, bolts, etc. It will be noted that, whenever less space than this was allowed in the tests, the efficiency was low, because the fracture occurred in the fastenings. In particular cases it may be necessary to use some bolts within the space mentioned to prevent the compression side from crippling, but such bolts should be as few

in number and of as small a diameter as can possibly be permitted."

When these precautions are observed, and proper care is taken in the design of the beam, efficiencies as high as 75 to 80 per cent. can be obtained with the joggled beam, together with deflections within 150 to 125 per cent. of those found with solid beams, while, with double-wedge cast-iron keys, a stiffness equal to that of the solid beam has been secured.

Movable Dams.

THE use of movable dams in connection with river-navigation improvements is much more general in Europe than in the United States, such dams being especially used in France and Italy, but with the increased attention which is being given to the subject in America such dams will doubtless be more and more generally used.

A very full paper upon this subject has been presented before the American Society of Civil Engineers by Mr. B. F. Thomas, reviewing what has been done in Europe and America, and practically constituting a complete review of the subject.

"The purpose of movable dams is to conserve the water in a stream during the season of medium flow, so that navigation may go on uninterruptedly through the lock, and restore the stream to its natural condition again (by lowering the dams) upon the approach of sufficient water for free navigation."

It is this important feature of adaptability to the condition of flow which gives the movable dam its great advantage over a fixed one, since it is often quite as important to provide for the excess of flow during the full season as it is to retain the water when the flow is insufficient to maintain a full channel.

"Another advantage they possess over fixed dams, which, however, seems to have been lost sight of, is that they are applicable to higher lifts, because they do not raise the level of the water during freshets above its accustomed height in the original condition of the river."

It is this point upon which Mr. Thomas lays especial stress, and he shows that the principal objection to movable dams, as at present constructed, lies in the fact that the lift attained is too small to justify the expense. The success of movable dams cannot be considered complete, until they have been applied to lifts at least equal to those which would be given to fixed dams at the points, and at no greater cost.

There are two general classes of movable dams,—those requiring extraneous power for their manœuvring, and those operated by the force of the water itself,—and of these main divisions many varieties have been made. In the first class belong the various types of trestle and wicket dams, and the so-called "needle" dam, while in the second are included the several forms of bear-trap, drum wicket, and similar constructions. The needle dam, which has been much used in various parts of Europe, operates by damming the water up by planks, called needles, which rest against bars connecting the fixed trestles at the top, and against a sill in the river bed. The needles are generally of small dimensions, and are operated by hand from a walk-way which passes across on the tops of the trestles.

Dams of the bear-trap and drum types have not been employed to any great extent on navigable rivers, and the most important feature of Mr. Thomas's paper is the description of the high needle dam at Louisa, Kentucky, on the Big Sandy river.

This important work, designed and constructed under the supervision of a commission of government engineers, is described at length, and is of especial interest because of the unusual height for a dam of this type, the needles being more than fourteen feet long, and the details of the trestles and apparatus for manœuvring being arranged with a special view to the safety and convenience of the men employed.

The method of operation can be described here only briefly, but photographs and drawings in the original paper give an excellent idea of the operations. The trestles, which are built up of steel channels, are so hinged to the sill that they can be laid flat across the bed of the stream, each nesting into its neighbor so that a

flat uniform bed is formed when the dam is down. This offers the least possible obstruction to the water, and prevents the lodgment of drift and possible injury to the works in time of freshet. The needles themselves are placed in position from a boat above the dam, and, owing to the size and weight of the needles, a power crane swinging from the bow of the flat boat furnishes the necessary power to place them rapidly and accurately in position.

Ordinarily the needles can be removed in a similar manner, as the gradual increase in the flow gives warning, but, when it is necessary that the dam be opened promptly, as in times of sudden rise, an arrangement of chain connections enables the needles to be removed in rapid succession, and with entire safety, by power from the shore. The trestles are raised and lowered by chain connecting to winding crabs on the piers and lock walls.

The experience thus far gained with this dam confirms the correctness of the view upon which its construction was based, and demonstrates that a high needle dam can be built and operated with success and safety.

Mr. Thomas's paper contains a full review of a great number of proposed and executed movable dams of many designs in various countries, and for this reason, as well as for the account of the Big Sandy dam, it will be accepted as a valuable contribution to a branch of engineering which has hardly received the attention which its importance deserves.

Aluminum for Electrical Conductors.

SINCE the rapid modern development of methods for the cheap production of metallic aluminum, the manufacturers have endeavored to find new applications for it, especially in lines which will absorb a large output and increase the demand.

Among the possible uses of aluminum, that of a substitute for copper for electrical conductors has been suggested by Mr. Alfred E. Hunt, whose share in the development of the commercial production is well known by all. Mr. Hunt, in a paper published in the *Electrical World*, gives some interesting comparative figures between the electrical conductivity of copper and aluminum, and shows that the conductivity of aluminum is about 63 per cent. of that of copper, while the weight of copper is 3.33 times that of an equal volume of aluminum. From this it follows that, even when the cross-section of an aluminum conductor is increased enough to give an equal conductivity, the weight will still be only about 48 per cent. of that of a copper conductor.

"To obtain, therefore, a conductor of aluminum at the same cost of metal per ohm per mile, the cost per pound of the aluminum may be about 2.1 times that of the copper; assuming the cost of the copper at 14 cents per pound, it is evident that aluminum at 29 cents per pound is slightly cheaper than copper."

In regard to the question of tensile strength, it is stated that aluminum wire can be furnished of the same tensile strength, per unit of area, as annealed copper wire,—say, about 32,000 pounds per square inch of cross-section,—but, as the aluminum wire is of greater area, the actual strength is greater in proportion.

It is practicable to produce alloys of aluminum of much greater strength than that above given, but their conductivity is less than that of the pure metal, although the prediction is made that an alloy can be made with a tensile strength of at least 65,000 pounds and a conductivity of more than 50 on the Matthiessen scale.

One objection which is urged against aluminum for this purpose is the difficulty of soldering, or brazing, the metal. It is possible to make a good soldered joint, but the operation is slow and difficult, and the galvanic action between the aluminum and the metals of the solder is much greater than between copper and the metals of the solder; hence the joint weakens more rapidly. Probably better success will be had by the use of mechanical joints.

Aluminum has been successfully used as an electrical conductor for several years, both at the Niagara Falls works of the Pittsburg Reduction Company and in a telephone line at the Chicago stock yards with satisfactory results as regards both conductivity and resistance to corrosion.

The Sanitary Arrangements of Hospitals.

SANITARY plumbing is now recognized as a most important factor of public health almost everywhere, but there is probably no place in which care in this respect is more important than in hospital buildings, where large numbers of disabled and diseased persons are gathered in confined areas.

A paper by Mr. William Paul Gerhard, published in the Albany *Medical Annals* treats in a very thorough manner of the plumbing, water-supply, and drainage of hospitals, and contains much that is of value and importance to architects and engineers whose work falls within this department of construction.

It is impossible to do more than indicate the points which are treated by Mr. Gerhard, and, for a fuller discussion, reference must be had to the original paper; but the principal features of the subject may be noted briefly here.

In regard to sewage disposal, it is wisely recommended that, even where the sewage is discharged into city drains, it is best to provide some means for purification, and at least to intercept all solid matter, paper, rags, etc., while, where city sewers are available, some method of sewage filtration through natural or artificial sand and gravel beds is recommended.

Abundant water-supply is a point strongly emphasized, fifty gallons per head per day being given as the minimum, while as much as two hundred gallons is the average daily consumption in some of the State hospitals. Mr. Gerhard naively recommends lavish use of water when it is freely supplied by city water works, but counsels economy when it is pumped at the expense of the hospital treasury. Purity of water-supply is naturally insisted upon, and a constant watch kept to detect subsequent pollution.

Some excellent hints are given in regard to plumbing details, and, while in general these are such as also apply to private houses, there are some features especially necessary for hospital service. The plumbing should be arranged in vertical groups, and rooms containing plumbing should never be entered from the wards directly, this point being especially imperative in the case of surgical wards. All plumbing should be separately trapped, and care taken that the traps may not lose their water seals, this object being effectively attained by using deep water seals for the water-closets, and non-siphoning water-seal traps under the other fixtures. Long branch wastes must in all cases be extended separately up to the roof, but the traps under the branches do not need a back air pipe. All plumbing arrangements should be as simple and direct as possible, and no encasing in woodwork or concealing of details anywhere should be permitted, everything being made perfectly accessible and in evidence.

Bath-rooms and lavatories should be arranged so that they can be washed down with hose, both walls and floors being finished with waterproof non-absorbent material, such as enameled brick, slate, or marble for the walls; and concrete cement, or tiles for the floors. In some modern hospitals spray baths are used entirely, and tubs have been altogether abolished; this method is recommended as simpler and better than the old system.

The lavatory arrangements for the hospital staff, including bath-rooms, should be entirely separate from the accommodations for the patients, and the operating rooms and clinical theatres must, of course, be constructed according to all the requirements of modern aseptic surgery. Kitchen attachments do not differ greatly from those for good hotel service, except in the greater care for an abundant supply of water, air, and light, and ample provision for cleanliness.

Good work, however, is only a part of the problem; capable, skilled supervision must be employed to keep even the best arrangements from deteriorating. As Mr. Gerhard well concludes:

"In a well-managed hospital the most thorough cleanliness and a pure condition of the air indoors are secured by constant vigilance against all manner of dirt. Half the battle is won where the buildings have a good system of sewerage and plumbing. These will not only prevent a contamination of the atmosphere in the toilet rooms,

lavoratories, and sick wards by emanations from the sewer pipes and plumbing fixtures, but they will also render it impossible for the soil upon which the building stands to become polluted and give off gases injurious to health and fatal in disease. They will finally assist in the maintenance of absolute cleanliness of the walls and floors, of a personal cleanliness, and purity of the water- and food-supply of a hospital."

These points, and many others which are discussed in the paper, and which are of most importance at the critical time when the original plans of a hospital are being prepared and executed, should not be left to architect, builder, and building committee alone; the services of a competent hydraulic and sanitary engineer should be secured at an early stage, for, even in the selection of a hospital site, questions of drainage and water-supply may and will arise, which can be decided best by the thorough knowledge and practical experience of a specialist.

Canals for Large Traffic.

We have already referred to the report of Major Symonds upon the advisability of constructing a ship canal from the great lakes to the Atlantic, showing that in his view the returns from such an enterprise are hardly likely to warrant the great outlay necessary. The other side of the question is discussed at length in a paper read before the American Society of Civil Engineers by Mr. Joseph Mayer, and it is probable that, by a comparison of these two views of this important matter, a safe and satisfactory judgment may be reached.

Mr. Mayer logically treats the subject as consisting of two opposing elements of cost. "There are," he says, "two kinds of cost incurred in moving freight,—cost of transport and cost of transfer. The best possible adaptation of the carrier to the route on which it travels will make the cost of transport the smallest. Canals of moderate depth will furnish very cheap transport, if the carriers are especially adapted to them. This best adaptation of the carrier to the route, for the traffic between the lakes and Europe, is, however, only obtainable by transfersin New York and Buffalo. These produce large costs of transfer and slowness of transportation, —the latter a disadvantage difficult to be expressed in figures, unless the higher freight rates and larger amounts of business which the railroads are able to obtain are taken as a measure of it. These costs of transfers can, on the route there considered, be partly avoided by using barges that are able to run safely and economically on the lakes and sea-coast. These barges, however, are not as economical on canals as mere canal barges, because the latter can be built much lighter. These lake barges need also a much deeper and more expensive canal. All transfer costs of through freight, and consequent delays, are avoided by a canal accommodating ocean steamers."

Taking these opposing elements into account, Mr. Mayer proceeds to discuss the relative advantages and disadvantages of canals of various depths, with the idea of determining the economic depth in view of the commercial conditions existing.

Taking successively into consideration canals of 12, 18, 24, and 28 feet in depth, with the attendant costs of deepening lake and harbor channels, and opposing the various costs for transport and transfer for the probable amount of traffic, fairly definite conclusions may be drawn for various distributions of the traffic.

On the assumption that the freight would be about equally divided between New York, points near the sea-coast, and European ports, the saving on an 18-foot canal, as against the present Erie canal, is estimated by Mr. Mayer at an average of $1.42 per ton. This estimate contemplates the use of barges which, while suited for coast delivery, would not cross the ocean. It is probable, however, that ocean-going barges could and would be designed for use on the lake, should a canal of 18 or 20 feet in depth be built between Buffalo and New York.

The advantages which attach to the use of large motorless barges are pointed out at some length, and the great economy in proportion to carrying capacity is empha-

sized. Motorless barges can be hauled by powerful tugs at the speed of lake vessels, when on the lakes or sea-coast, and, when in the canal, by small tugs. Large motorless lake or ocean-going barges, therefore, fulfil most nearly the conditions for speediest and cheapest transport,—namely, absence of transfers and best adaptation of carrier to route.

A marked gain in time in such a canal as is here considered would be effected by the substitution of some form of mechanical lock,—such, for instance, as Dutton's pneumatic lock—for the lock systems now at Niagara Falls and Cohoes, one or two drops taking the place of a series of common locks, with their accompanying delays and inconveniences.

Mr. Mayer does not claim to have settled the subject definitely from his point of view, and admits that no calculations and inferences can be more reliable than the data on which they are based; in closing, he states that the question can be settled only by carefully analysing the cost of transportation, separating it quantitatively into its different elements, finding how these elements are affected by different kinds of canals and carriers, and then choosing that combination which will make the sum of all the elements of cost a minimum.

Hydraulic Rams.

THE hydraulic ram is so simple and well-known that it seems as if all that ought to be known about it should have been put upon record long ago; but, when one comes to look up authoritative and reliable data concerning performance and efficiency, the meagre nature of our information becomes apparent. It is, therefore, a matter of interest to find a paper upon the subject presented by so well-known an engineer as Mr. John Richards before the Technical Society of the Pacific Coast, and published in the *Journal of the Association of Engineering Societies.*

Although invented more than one hundred and twenty years ago, the hydraulic ram has not improved as rapidly in the United States as have other forms of machinery, but, rather, has degenerated into a sort of staple article, like hardware, with a continual effort toward cheapness, so that the rams now made in America are distinctly behind those of European makers in design, efficiency, certainty of action, and especially in devices for use against high pressures. These points may be clearly shown by comparing illustrations of rams made in the United States with illustrations of those of English, Swiss, French, and German builders. The European machines cost four to five times as much as those offered in America.

On the subject of the literature of the hydraulic ram, Mr. Richards says truly that it is scant and of bad quality, and has never lent much aid to those engaged in their construction. The theoretical and computable elements involved in the action of hydraulic rams are simple, so far as the principal forces are concerned, but the conditions and phenomena of their action—in the case of small rams, at least—have made it necessary to base all rules on observed, instead of computed, results. The various engineering hand-books give but little information, and that little has been copied and recopied from the theoretical discussion of General Morin, and from the papers of d'Aubuisson and Eytelwein, with but little regard to the actual performance of machines in daily work. Even so careful an authority as Molesworth gives a number of antiquated rules, in which the efficiency is involved with the ratio of lift to the supply-head, whereas, as a matter of fact, if the machine is properly proportioned to the work it has to perform, the efficiency should be uniform, or nearly so, for all heads within common practice,—with a limitation, hitherto neglected, based upon the resistance offered by the inertia of the water resting on the check valves.

The most important feature brought out in Mr. Richards's paper is the fact that the so-called "ramming" action of the escape valve is not only objectionable, but also unnecessary and undesirable. As a matter of fact, this concussive action has nothing to do with the performance of the ram, and is destructive and without purpose. Mr. Richards himself has designed rams

with valves which are operated by the reaction of the escaping water instead of its impingement; these operate much better than the older form, but the highest efficiencies have been attained by the Pearsall machine, and by a still later form of Mr. Richards's design, in which the waste valves are operated mechanically. A very simple and effective form of such a ram is one in which a small overshot wheel, operated by a little stream of water from the supply-head, operates a cylindrical intermittent waste valve with a periodicity entirely under control, and altogether independent of the action of the water itself. It is also thus possible to make the valve so quick-closing as greatly to reduce the usual waste at this point, and, as the volume of water that escapes after the waste valve begins to close is from 15 to 25 per cent. in rams of the ordinary form, the economy of this improvement is evident.

As a result of his general analysis of the subject, Mr. Richards suggests that, for small rams, it is advisable to subdivide the escape valves, and increase their number, thus keeping the range and time of closing down to that required for one small valve.

For rams of larger sizes, grid or multi-ported valves are recommended, or, for the largest rams, with inlets exceeding 12 inches in diameter, rotary lantern valves; the operation in either case is mechanical, an ante-compression chamber being employed to avoid concussive action.

The Diesel Motor in America.

WE noticed very fully in these columns the notable advance in internal-combustion motors made by Herr Rudolf Diesel promptly upon the presentation of his original paper before the convention of mechanical engineers at Cassel, in June of last year; and since then many accounts of the Diesel motor have appeared in the technical press in Europe and America.

Probably the fullest presentation of the subject—apart from a translation of the original paper in the columns of the *Progressive Age*,—that has been made in the United States was a paper read before the Engineers' Club of St. Louis by Colonel E. D. Meier, who has had the opportunity of investigating the motor in Germany, and who is especially competent to discuss it from the standpoint of the specialist in power generation.

"Ignoring for the moment the patented details of the engine itself, Diesel's main invention is a *process* for converting the heat energy of fuel into work. It consists in first compressing air, or a mixture of air and neutral gas or vapor, to a degree producing a temperature above the igniting-point of the fuel to be consumed; then gradually introducing the fuel for combustion into the compressed air, while expanding against a resistance sufficient to prevent an essential increase of temperature and pressure; then discontinuing the supply of fuel, and further expanding without transfer of heat. This is, then, a process embodying in part the best of our steam-engine methods. But Diesel, by using only permanent gases for the vehicle of the expansive force of heat, avoids cylinder condensation. He has less loss of heat to the cylinder walls, because these gases have less conducting power than steam. The compression before admission, which we find so essential to the smooth working of the steam engine, he uses to a far greater extent. In fact, his upper limit of pressure is reached by the compression itself. Even the combustion does not essentially increase his temperature or pressure, since it does mechanical work during its entire continuance, and, after that, during expansion.

"The sudden blow on the piston, which occurs even in the steam engine, and is unchecked and violent in all previous internal-combustion motors, is entirely avoided by Diesel, for his adiabatic compression is gradual and complete. In place of the 30-per-cent. of clearance in previous gas and oil engines, he has less than 7, and this small space is filled with air compressed to over 500 pounds' pressure and at a temperature of over 1,000 degrees.

"Into this the petroleum is slowly and gradually injected during a predetermined part of the stroke by means of compressed air, compressed by a separate air-pump to

a temperature higher than that in the working cylinder. The result is a gradual and complete combustion, so that the exhaust of spent gases is noiseless, odorless, and invisible."

Comparisons of cost show that with the Diesel motor with Illinois coal at $1.10, the fuel cost alone, for 100 h. p., is about 62 per cent. of what it is with a Corliss engine of the same capacity. With eastern coal of better grade,—taking into account the superior steaming power,—at a price of $2.80 per ton, the fuel cost with the Diesel motor is only 35 per cent. of the fuel cost with the Corliss engine, fuel oil being taken at 2 cents per gallon in both cases.

The manufacture of the motor has already been taken up on a large scale, shops in France, Germany, Belgium, Switzerland, Denmark, and England having been licensed to build the new engine; and it is understood that the United States is also to be included in the list. In conclusion, the question whether the Diesel motor will supersede the steam engine in time is seriously discussed. "Certainly our European colleagues believe that it will. In America, of course, the conditions are different. Our fuel is cheaper and more abundant, and we are less inclined to economize in that item. But our labor is much higher, and, as the labor account shows a large balance in favor of the Diesel motor, I see no reason why, with the natural development of type after type, the Diesel motor will not obtain the lion's share of the work now done by the steam engine."

A Large Filtration Plant.

IN many cities the problem of pure water is exciting much attention, and, in view of the limited control of river sources, the question of purifying river water by filtration has received consideration in many places.

At Lawrence, Mass., a sand filter plant with a capacity of 5,000,000 gallons has been installed, this being the largest sand-filtration system in the United States, while at Wilkes-Barre, Pa., is a mechanical filter plant of double the capacity; but both of these will be excelled by the sedimentation and sand-filtration system about to be constructed at Albany, N. Y., and to have a capacity of 15,000,000 gallons per day.

From a description in *Engineering News*, based upon the plans and specifications of Mr. Allen Hazen, the following points are obtained.

The work includes a sedimentation chamber of a capacity of 16,000,000 gallons; eight masonry-covered filter beds, with an available area of about 0.7 acre each, and a total daily capacity of 15,000,000 gallons, but expected to work at a lower average rate; a masonry-covered pure-water reservoir, with a capacity of 600,000 gallons; and all necessary appurtenances for a complete water-purification plant, including devices for aerating the water before sedimentation, regulators to control the rate of filtration, a bacteriological laboratory, and sand-washing apparatus.

Formerly the water-supply of Albany was effected entirely by gravity from a number of small streams, but, as this became insufficient, pumping from the Hudson was resorted to; and, as the intake was near the heart of the city and sewage discharge entered the river at higher points, the result was anything but healthful or safe.

The new plans include a change of location to a point further up the river, where the water will be pumped to the sedimentation basin, and, after filtration, will be delivered by gravity from the pure-water reservoir to the present pumping station.

The delivery to the sedimentation basin is made from the pumping-main through inlet pipes pierced with small holes, dividing the water into small jets and affording sufficient aeration. From the sedimentation basin the water flows to the filter beds, the inlets being at the corners of each bed; after filtering through four feet of sand and one foot of gravel, it passes into vitrified salt-glazed pipes, laid with open joints to admit the flow and conduct it to the reservoir.

The filter beds are to be covered with groined arch vaulting of concrete, with concrete floors and clay puddle beneath.

THE BRITISH PRESS

Engines for Electric Traction.

AT the annual meeting of the Institution of Mechanical Engineers there was an animated discussion on the subject of engines for electric traction, there being material difference of opinion as to the best type of engine for this service. While the principal feature of difference appeared to be that of long-stroke slow rotative speed as against short-stroke high speed, it might more properly be described as relating to the effect of sudden changes of load upon the engine itself.

The extent to which American precedents in electric traction are to be considered as applicable to English conditions was the subject of much of the discussion. In the United States, where electric traction has been in use for more than ten years, the use of short-stroke high-speed engines has largely been abandoned in the great power houses, and larger long-stroke condensing engines adopted, using heavy fly-wheels and governors adapted for the fluctuating loads. In England the present tendency, at what is almost the introductory period of experience in electric traction, is towards the use of light, quick-running engines, of which the Willans engine may be considered a typical example, and in which the division of the effort around three points of the circle permits the use of light fly-wheels, while attaining close regulation with varying loads.

There is no doubt that, when all the points are taken into account, either system may be made to answer perfectly, and it is only when attempts are made to apply engines to work for which they are obviously unfit that unsatisfactory results will follow. The Willans engines used at Liége have proved well adapted for tramway service, but so have the many installations of long-stroke Corliss engine in the United States. There is no doubt that a high rotative speed permits a much lighter fly-wheel, and that prompt and efficient governing can be attained in a form of engine which is in effective connection with the governor more frequently in the same space of time than is the case with the slower engine.

The real reason why the large, slow-speed engines have come into so general use in the United States is that they are more economical in the matter of steam than the quick-running single automatic engines which for a time had such vogue in electric lighting and power stations.

Among the engineers who took part in the discussion, several had had personal experience of existing practice in America, among whom may be noted Mr. Jeremiah Head, Professor Unwin, Mr. Holroyd Smith, and others; while these experienced engineers were not disposed to affirm the entire adaptability of American practice to British conditions, they were inclined to think that the results of ten years' experience over thousands of miles of tramway were not lightly to be cast aside. As Professor Unwin put it: "The American engineers might, or might not be wrong; but what they had done was the result of actual experience, and for this reason was of more value than seemed to be attributed to it."

As a matter of fact, there is no reason why an electric-power plant should be treated in a different manner from any other power plant; each case should be considered in view of the especial conditions obtaining. This was clearly set forth by Professor Kennedy, who warned engineers against taking a partisan view of the merits of high- and low-speed engines He thought the whole subject should be considered as a problem in mechanical engineering, taking into account the merits on both sides. The introduction of electrical traction in England will be effected more advantageously because of the experiences of those countries which were earlier in the field, considered in the light of the different conditions which naturally exist.

Improvements in Transport Facilities.

In his presidential address before the Society of Engineers, Mr. W. Worby Beaumont discussed a number of interesting features in connection with possible improvements in the application and use of mechanical motive power, principally from the point of view of a critic of a conservatism which permits the wasteful methods of power use now in vogue to continue.

We see this conservatism in mills where antiquated engines, badly-balanced shafting, and impure boiler-feed water are daily wasting money which could readily be saved, or rather used; we see it in collieries where badly-prepared coal is sold at unnecessarily low prices for lack of proper care; and, most of all, we see it in the enormous waste of time and money by the use all over the country of double the horse power that would be necessary for cartage if anything but antiquated notions prevailed as to the construction and maintenance of roads and of the vehicles that run upon them.

Taking up the subject of horse hauling, Mr. Beaumont estimates that there are about 1,500,000 horses in the United Kingdom, and that, by small improvements upon the present methods of constructing and maintaining road-surfaces, at least one-tenth of these could be dispensed with. In order to be on the safe side, however, he makes his computation upon 500,000 horses. To save only one-tenth of this number of horses would mean a saving of £1,500,000 a year, and all the other 450,000 horses would be able to earn from 5 to 10 per cent. per year more than at present. Taking it at 5 per cent. year, the saving on this head would be £2,250,000 per year, or a total of £3,750,000, which, capitalized at 3 per cent., represents a principal of £125,000,000, so that at least £100,000,000 might profitably be invested in the improvements of the highways.

Improvement of roads would lead to the general use of motor vehicles; on this point, as might be expected, Mr. Beaumont is especially emphatic.

"If we are to have the advantages of cheap and rapid transit between the hard and fast points of railway service, we must have mechanical power on the roads. Already the importance of this is recognized, but it is necessary to point out that, to secure the greatest possible advantages of this, we must have not only the mechanically-propelled vehicles, and the roads suitable for their working, but that these very road improvements are as desirable for the horse-propelled vehicles.

"Over many miles of suburban and country roads the construction of really well-made macadam roads, with wheelways at the sides, will make a splendid national investment. The better the road, the longer it lasts, the less the time lost by stoppages of traffic for heavy repairs, the greater the average speed of goods and passengers.

"The haulage-resistance on well-finished macadam roads is less than half that on a badly-made road of the same kind. This means more than the fact that one horse would do the work now done by two, and do it quicker. With the improvement of the worst gradient one horse could, in many parts, do the work now done by three, for it happens frequently that the full power of the two or three horses of the team is only required for a fraction of the whole road traversed. Further than this, it means that the mechanically-propelled vehicle could do with either less than half the steam engine power now necessary, or could carry greater loads, and the average speed would be greatly increased without making any addition to the full speed. In fact, the maximum speed could be reduced, and a higher average speed attained. With the improved roads the cost of fuel, either as horse feed or as coal or oil, would be enormously reduced, especially in the case of horses, and the distance traversed by mechanical road vehicles with one supply of fuel and water would be proportionally increased."

"Now, I believe improvement of our common roads to suit the possibilities of mechanically-propelled vehicles, and the design of the vehicles to suit the possibilities of high roads, will, in the future, make a change almost as vast as that which has been wrought by the mechani

cal horse on iron roads. We have our roads leading from everywhere we want to go or send goods to our houses and factories. We want to take advantage of the powers which the steam engine will place in our hands if we will but give a fraction of the ingenuity to the construction of roads which we have given to the construction of this world-changing motor."

"On the road-construction and -maintenance of the future depends the development, not only of the machinery required for the purpose, but of high-class self-propelled vehicles for every application; and on the improvement of road communication between towns and villages depend not only great engineering industries, but the growth in the value of land."

Hydraulic Jointing.

THE customary method of joining the tubular portions of bicycle frames to the intermediate connecting parts is the time-honored process of brazing; but recently a method of expanding the tubes by internal hydraulic pressure has been devised, and, by the use of powerful special machinery, some effective work has been accomplished. From an account of the Crowden system given in the *Engineer*, the process, and the machines used in connection with it, may readily be understood.

The sockets at the crank-hanger, front-swivel, and seat are made with grooves on the inside, these grooves being given the form of a double helix, in order effectually to resist the twisting stresses; and, when a pressure of seven tons per square inch is exerted upon the inside of the tubing, it is expanded into these grooves in a manner that insures a very strong union and connection. Such a pressure naturally tends to enlarge the entire tube, however; hence, some method is necessary to prevent the tube from expanding anywhere except in the sockets where the joints are to be made. This support for the tubing is provided by special jigs, or frames of great strength, carrying dies which surround and support the tubes and sockets on the outside, the jigs being made in halves so as to admit the frames readily, and the dies of various sizes and shapes to admit different kinds of bicycle frames.

Much ingenuity has been expended upon the details of the special machines, these being largely due to Mr. Johnson, by whom the process is operated; and the succession of operations has been so thoroughly worked out that, it is claimed, the entire process of making all the joints in a frame occupies only about three minutes.

The use of expanded pipe joints is well known in steam-boiler practice, and is there found to be perfectly satisfactory, and there appears to be no good reason why a similar method should not work well in bicycle construction. The conditions of use, however, are so different in the two instances that only the test of practical hard usage for a considerable period of time can determine whether the system will stand the jarring vibration and lower factor of safety. If the permanent strength of the joint is demonstrated, and no tendency to work loose is developed, the method should come into extensive use, as all heating of the steel is avoided and a material saving in time and labour effected.

Power from Furnace Gases.

WE have already referred in these pages to the attempts made in various places to use the discharge gases of blast furnaces in internal combustion motors as a direct source of motive power, instead of adopting the less direct plan of burning them under boilers for the generation of steam. An excellent measure of success has been attained in this direction in Belgium, and now we have information of similar experiments in Scotland.

A paper by Mr. William Galbraith in the *Colliery Guardian* gives a detailed account of the tests at Wishaw, near Glasgow, adding some valuable experimental data to the information already available. Mr. Galbraith shows that the coal burned in a furnace making 300 tons of iron per week produces gas sufficient to generate nearly 1,800 h. p. on a basis of 4 pounds per horse power per hour, which gives an idea of the enormous amount of power

passing unutilized from the tops of our furnaces.

The plant at Wishaw consists of an Acme gas engine, capable of developing 30 brake horse power with Glasgow gas, the cylinder being 12 by 20 inches, with a Thwaite plant, consisting of a small coke scrubber, a physical purifier, gasholder, small fan, etc., and is connected to a compound-wound dynamo, the whole at present being used only for lighting purposes.

A number of careful tests were made with this plant, using gases from the blast furnace, with the result that about 15 h. p. was developed by the consumption of about 90 cubic feet of gas per horse power. The analyses of the gases showed that the effective constituents were present in about the following proportions: 26 per cent. of carbonic oxide, 2 per cent. of methane, and less than 1 per cent. of hydrogen, the thermal value running about 135 B. T. U. per cubic foot. One pound of coal yielding about 58 cubic feet of gas, 1.54 pounds of coal are needed per horse power.

"It is clear that the gas, being different and much poorer in combustible gases than the ordinary retort gas, would not develop the same power in the gas engine; and, as the latter was, of course, designed to use retort gas, certain modifications had to be carried out on the engine. With the exception that the engine is rather over loaded, or, rather, that sufficient margin had not been allowed for the difference in the explosive power of the gases, these modifications, which were not of a serious character, proved entirely successful, and for many months the engine did its work with as little trouble as the steam engine which it replaced."

Subsequently certain irregularities in ignition appeared, and an investigation by Prof. Rowden developed points interesting to those who are attempting to use blast-furnace gases for motive power. Owing to the poor nature of the gas, the spread of the flame from the point of ignition was much more sluggish than with the richer illuminating gas for which the engine was originally designed. The ignition was effected by the uncovering of an incandescent tube by a timing valve, but the slow response of the furnace gases rendered this method of regulation of lead uncertain. By providing a larger and quicker opening valve, a much better ignition was effected, and the action of the engine was made as certain and effective as with the illuminating gas, the only difference being in the reduced power, due to the poorer quality of the gas.

Altogether, the results of this experience at Wishaw are most encouraging, especially because they were achieved by a plant actually in operation rather than by a brief experimental test.

Prof. Rowden does not hesitate to express his favorable opinion of the practice of using furnace gas, and says: "My observations lead me to think that the gas from the Wishaw blast furnaces is superior in quality, and more uniform in composition than the average gas from a Dowson producer."

The Care of Steam Boilers.

NOTWITHSTANDING the great advances which have been made in the construction and operation of steam boilers, it is still true that in many important locations this important feature of every steam plant is often sadly neglected. A leading article in *Engineering* discusses this subject in a forcible manner, and brings out clearly the weak points in steam boiler operation and the care which should be given to keep a good boiler in proper working order. Many of the facts about the neglect to which boilers are subjected would hardly be believed, if they were not obtained from the evidence brought out in the board of trade reports upon boiler explosions, but investigations after explosions may at least assist in preventing other disasters, and all such information should be given a prominence which the importance of the subject demands.

"Whether an owner ought to place his boiler under the charge of some inspecting company, or not, of course depends to a certain extent on special circumstances. If an owner has in his employ, or can command the services of, a thoroughly competent man, whose duty it is to periodically

examine the boiler, and who has power to have all necessary repairs carried out, he being made responsible that such repairs are carried out, then such outside inspection may be dispensed with, although even in such cases the extra security given by an independent inspection is well worth its very moderate cost. Where, however, the conditions just named are wanting, the periodical inspection of the boiler by a competent inspecting company is an absolute necessity."

The two great enemies of steam boilers are corrosion and incrustation; corrosion because of its direct reduction of the strength of the metal, and incrustation because of its indirect influence in causing overheating. A third source, similar in effect to incrustation, but differing widely in nature, is the accumulation of coatings and deposits of grease upon the surfaces of the boiler, this being a frequent cause of injurious overheating. The increasing use of surface condensers, and the feeding of the greasy condensed steam into the boilers, are undoubtedly responsible for many collapsed flues and burned crown sheets. An entirely satisfactory method of freeing condensed steam from the cylinder lubricant has not yet been devised, although numerous filtering devices are made which partially accomplish the result. The presence of oil in the boiler is especially objectionable when the water contains lime, as the combination forms a spongy mass, which is a very bad conductor of heat.

Theories of corrosion based upon electrolytic action appear to have lost ground of late, although there is still much difference of opinion on that score. The efficacy of zinc in boilers as a preventive of corrosion is still accepted by some who are well qualified to speak, but the exact nature of its action, as well as the separation of such action from that due to other causes, is still unsettled.

Very pure waters often exhibit a very active corrosive effect upon boilers, and this action can be explained only upon the assumption that it is caused by the liberation of the oxygen and carbonic acid dissolved in the water. Waters containing gases are also objectionable from the persistence with which the bubbles of separated gas cling to the metallic surfaces, permitting overheating, and hastening corrosive action. It is probably this separation of corrosive gases which causes the pitting of feed-water heater tubes, and makes the use of brass or copper tubes necessary.

"The best remedies for corrosion are generally the simplest and least expensive; but, after all, there can be no hard and fast rule laid down as to what should and what should not be used, as so much depends on the water, the kind of boiler, the conditions of work, and many other things. Perhaps two of the simplest remedies ever used as a safeguard against incrustation are petroleum and common soda; but even these must be used with care, and in the proper proportions; else the evils that they cure may be less than those they bring about; and it all comes back to what we said before,—that steam-users should have some competent man to advise them, be he the engineer to a boiler inspection company, or any one else capable of giving sound advice on the subject.

Engineering Appliances in Mining.

IN an interesting paper read before the Manchester Association of Engineers, and published in the *Colliery Guardian*, Dr. C. M. Percy reviews the relation of the work of the mechanical engineer to the operations of mining, and points out features worthy of careful consideration. Although the paper is practically confined to coal mining, much of the matter is general in character, and even the coal-mining industry is important enough to demand interested attention to this aspect of it.

The writer first reviews the progress made in the past generation in mechanical appliances in mines, especially the improvements in conveyance and ventilation. The systematic manner in which the underground conveyance from the furthest workings to the pit bottom is effected is one of the best pieces of mechanical engineering in mining work. In ventilation the immense increase in the volumes of air handled is a feature well worthy of

note. In an average colliery, working, say, 500 men underground, the quantity of air passed through the mine represents an actual weight of 500 tons per hour, and, as a matter of fact, the weight of air passing through a coal mine is enormously in excess of the total weight of coal and water and dirt and everything else raised, reaching thousands of tons each year for every individual miner.

The winding machinery of a mine is an important contribution of mechanical engineering to mine operation, and its action is a peculiar operation, in which a more than moderate efficiency is impossible. Each operation occupies less than a minute, and comprises, first, the starting from rest, accelerating to a speed of sixty miles an hour; second, running at that high speed for a few seconds; third, falling away to rest again. With this must be combined such control as shall render accidents practically impossible. The great improvements in the construction of winding ropes has added much to safety, and Dr. Percy holds that assurance of great strength in the ropes is the best precaution against accidents that can be taken, —better than the use of appliances to prevent injury after a rope has parted.

In discussing the lines of future improvement, Dr. Percy brings out some important points. Among these is the rather natural fact that at the coal mine, where fuel is plentiful, it is used in a most wasteful manner. Although there are no exact figures available, a close estimate shows that about 5 per cent. of all the coal mined is used in raising it to the surface, this including, of course, all the power used at the collieries for various purposes.

Taking this consumption in connection with the average depth of the pits, and computing the quantity of work performed, he concludes that, compared with the performance of the most economical modern engines, the steam machinery at the collieries uses about ten times as much coal as is required to generate the same amount of power in high-class mills and factories.

The pumping machinery used at the mines is not so wasteful, and many of the pumping engines now used compare favorably in point of economy with pumping engines anywhere. The hauling machinery, to which reference has been made, is deficient mainly in that the limit of distance is too soon reached. When electrical transmission has been made absolutely safe, power will be transmitted to distant points by electricity rather than by compressed air. This is especially important in connection with the extension of the workings under the sea. Coal, several yards in thickness, is now being worked at a distance of three miles off the coast of Cumberland, and coal measures are known to exist under the sea on both the east and west coasts. By the use of electrical transmission, power could be delivered to such workings with little trouble.

In the introduction of coal-cutting machinery there is room for advance. "In very many cases coal-cutting machines could do good work, not so much in the direction of diminishing the actual cost of production, but by increasing the value of the product in lessening the waste. The pick of the collier is a very handy appliance, and is not likely to become an absolute relic of the past; but, although in the hands of an expert workman, it does good service, it is wasteful. What with shattering by high explosives and crushing with the pick, nearly one-half of the coal is sent to the bank as slack. The difficulty has been in the application of a suitable and convenient power by which the machines can be put to work anywhere and this power transmitted by a simple wire." If electricity is advanced to such an extent that it can be used to transmit power safely in coal mines, coal-cutting machines are likely to come into extensive use. At present, however, the sparks from which electric appliances are as yet not entirely free are too probable sources of gas ignition to be permitted in mines which contain even a small proportion of explosive gases. It is more than probable that electrical machinery for use in mines will soon be made entirely safe, and then, doubtless, the electric plant will be a part of every modern mine equipment.

Engineer and Architect.

A LATE issue of the *Building News* contains an article on the relations of the architect to the engineer which may be read with profit by both.

It is the scientific application of engineering principles to architectural work which distinguishes modern work from that of past times. "Mechanical principles enter into the design of our construction at every step, which our forefathers knew nothing about. Formulæ and rules are applied to such matters as arches, vaults, roofs, girders, and columns. Certain canons of proportion, geometrical and numerical, probably taught the mediæval architect how to proportion his pillars, arches, and other masses of masonry. They were results derived from experience. Now the same things are regulated by graphic statics or mathematical analysis. If we want to construct an arch of masonry that shall be in equilibrium, we proceed, according to rule, to find the load which it has to bear, and to equate the moment of thrust with that of abutment, or graphically by means of a force polygon, by which we can determine the thrust of every arch stone, or the line of resistance within the thickness of the arch. So, too, we have mechanical means of finding out what depth and size beams of iron must be in order to carry certain weights. If we discard these rules, we do so at the risk of failure. The public expects the architect to understand them,—to know what is necessary to insure stability. In such matters as hydraulic apparatus, lifts, hot- and cold-water supply, laboratory and workshop fitting up, bath and laundry arrangements, etc., mechanical considerations and contrivances enter largely into the design of the architect. They require him to study departments of science which lie outside his particular art. They often interfere with his taste, and rob him of that serenity of thought so necessary to artistic conception. At every turn engineering forces itself upon his attention; he cannot ignore it."

While there is much that is true in these remarks, it seems hardly a problem of modern work and art; the finest works of ancient and mediæval times were executed by men who were at the same time artists and engineers, and who found that the two arts and sciences were rather mutual aids and helps than distraction. The calm study of an engineering problem often contributes as much to serenity of mind as does the contemplation of a beautiful design, and the fact that an architect has worked out the stresses and lines of resistance in an arch is more than likely to result in a graceful and artistically-proportioned piece of work.

The painter or sculptor studies anatomy, perspective, proportion, and all the scientific details of his art, and finds them aids rather than distractions. The musician does not find a knowledge of the mechanical rules of counterpoint and harmony, and of the laws of sound, a hindrance to the true mastery of the artistic side of his profession. The same should be true of the architect, and, casting aside limited and narrow ideas, he too should welcome the aid and coöperation of the engineer and his science, feeling sure that art can never suffer by close alliance with truth.

The Utilisation of Wave Power.

THE many attempts which have been made to harness the power exerted by the endless beating of the waves have been crowned with success only in a few limited instances. The reasons for this are readily found, and reside largely in the erratic nature of the motion, and in the mechanical difficulties which oppose the connection of the source of power with the shore.

One of the most successful applications of wave power, although in a most limited way, is the well-known "whistling buoy," which abstracts enough mechanical energy from the motion of the waves to keep the sound of its alarm whistle in continual action without other assistance.

The success of the whistling buoy has doubtless been the suggestion of Mr. Morley Fletcher's "Wave Power Electric Buoy," which is the latest attempt to utilise the power of the waves; and from an account in *Industries and Iron* we gather the following general description.

The principal feature of Mr. Fletcher's device is the fact that all the apparatus is contained within the buoy itself, thus getting rid, at one stroke, of the great difficulty in previous wave motors—*i.e.*, the connection with the shore.

In the interior of a floating buoy is a pump, which, by connection with the comparatively stationary anchorage, makes a stroke every time the buoy rises and falls. This pumping action, in connection with suitable air-chambers, maintains a body of water under pressure which, acting upon a hydraulic motor, keeps a dynamo in motion, and generates a current. The electric current thus generated may be used to feed a lamp upon the buoy, or, as suggested by Mr. Fletcher, may be used to charge the accumulator of an electric launch.

The details are matters which may be varied to suit the conditions of each case. The principal features to be noted here are the self-contained nature of the apparatus, and the scope afforded for the utilisation of wave power by the introduction of the idea of isolation.

It is easy to see that this idea may be extended to the motion of a vessel at sea, and that the rise and fall of the hull upon the waves—a motion which derives its origin entirely from outside sources—may be used in connection with proper storage devices to provide for much of the work now performed at the expense of much combustion of fuel.

The Stability of Channels.

ONE of the greatest difficulties encountered in connection with harbor improvement works lies in the tendency of channels formed in sandy estuaries to shift their positions, especially if there is no large river discharging through the estuary in which the channel is situated.

This question was the subject of a paper by Mr. P. M. Crosthwaite, read before the Institution of Civil Engineers at a recent meeting, and some of the points brought out are of interest.

The only action which can be relied upon when there is no river current is the scour obtained from tidal waters; in some instances attempts have been made to assist the maintenance of a dredged channel by means of training works.

Experience has taught, however, that training works constitute a hazardous experiment, and may lead to disastrous results. While they doubtless fix the direction of the channel, the quantity of water admitted and emitted at each tide is diminished, reducing the velocity and diminishing the scouring capacity. An increase in silting necessarily follows, while those parts of the estuary behind the training work are raised and the tidal capacity of the channel diminished.

Mr. Crosthwaite contended that by the use of dredging alone these injurious results do not follow, the reduced friction causing increased velocity and scour, while the quantity of water passing up and down the channel, being greater than when training walls are used, prevents the filling up of the estuary.

As an illustration of the action of training walls, the works of Dundalk Harbour were cited. Here a small river is trained through an estuary encumbered by vast sand-banks, the walls being raised to half tide-level. As a result, the general level of the sandbanks has been raised, and in some places as much as six feet of sand have accumulated, the training wall in one place being completely buried. Large accumulations of sand have been formed in the channel, and the bar has moved about one-fourth of a mile seawards.

The navigable channel is now constricted to a narrow deep cut close to the west training wall, which it threatens to undermine; if this wall should be undermined, the river will probably form a new course for itself through the western sand banks. The actions are just what the theory of Mr. Crosthwaite indicates, and, as all these changes have occurred within the short period of fifteen years, the rapidity of the accumulation will be evident.

These works were planned nearly forty years ago, when training walls were considered the only method of dealing with such channels; but, in the light of such experience, opinions must be revised.

THE CONTINENTAL PRESS

The Prizes of the French Academy.

AMONG the important functions of the *Académie des Sciences* is that of custodian of various funds from which prizes are awarded, as well as the difficult task of deciding to whom, in the various departments of pure and applied science, these prizes are to be given. These prizes are awarded early every year, and from the account in the *Comptes Rendus* some points of interest concerning the subjects relating more nearly to engineering work may be found.

The most important award in the department of mechanics for 1897 was that of the extraordinary prize of 6,000 francs from the funds of the department of marine, which on this occasion was gained by MM. Gossot and Liouville for their investigations of the subject of resistance of simple and reinforced tubes to internal pressure, with especial reference to the stresses in the metal of hooped guns under the action of military explosives.

In the usual method of computing these stresses the question is considered as one of statical equilibrium, and a definite and uniform pressure is supposed to be exerted upon the interior of the barrel. MM. Gossot and Liouville have assumed no such simple state of affairs, but in their memoir have taken into account the fact that the sudden pressure of the explosion is a maximum at the breech, and is transmitted thence to the muzzle at a rate depending upon the rapidity of the explosion, and that it is necessary to take into account the time element, if a correct understanding of the real conditions is to be obtained.

After a number of careful experiments, a simple mathematical expression was found for the pressure at any point of the interior of a gun in terms of the time and the maximum pressure at the instant of explosion, certain constants depending upon the character of the explosive introduced. From this expression a mathematical treatment based upon the elastic theory of the strength of materials was made, which enables the stresses to be computed far more intelligently than heretofore.

The Montyon prize was awarded to the engineers of the Aisne and Marne canal, MM. Bourguin, Pavie, and Pigache, for their successful application of cable traction to canal haulage. The installation for which this award was made is in the canal tunnel of Mont de Billy, this section of the canal having been for some time badly congested with traffic. The tunnel permits the passage of only a single boat, and, in spite of the use of expensive relays of horses, it has not been possible heretofore to make the passage in less than six hours; four passages, two in each direction, being made each twenty-four hours. As this canal is the principal connection between the two systems of the north and the east, and the yearly traffic has reached 1,400,000 tons, some means of relief became imperative.

The new system involves the use of an overhead cable, making haulage possible in either direction, according to the part of the cable gripped by the boat; and, apart from the economy in operating expense, the speed of traction has been increased one-third, and the loads also augmented, so that the actual capacity of the tunnel for traffic has been doubled, and the congestion in great measure relieved.

The subject announced for the Fourneyron prize was as follows:

"Give the theory of the motions, and a special discussion of the conditions of stability of apparatus of the velocipede class, bicycles, etc., both for rectilinear and curvilinear paths, either on a horizontal or inclined plane."

Ten memoirs were received in response to this announcement, only one being of a theoretical nature, the others being based upon practice; and, although several of the papers appeared worthy of seri-

ous examination, the committee deemed it advisable to prolong this competition for another year, and admit additional competitors.

Among the other awards, the following, though not directly within the domain of engineering, are of interest: the Cuvier prize of 1,500 francs to Professor Marsh, for his work in palæontology; the Lalande prize of 540 francs to Professor Perrine, for his discoveries of comets; and the LaCaze prizes to Professor Lenard for his investigations of the cathode rays, to Professor Röntgen for his applications of the X rays to therapeutics, and to Professor Sabatier for his researches in mineral chemistry.

Embankment Construction in Sliding Earth.

ONE of the most difficult problems with which the civil engineer has to contend is that of construction in those geological formations which are apt to shift and slide beneath his work, and which, even when most carefully considered, often contain such elements of uncertainty as to cause much anxiety.

A series of important papers upon this subject have appeared in the *Zeitschrift des Oesterr. Ingenieur und Arch. Vereines*, prepared by engineers Ottokar Soulavy and Carl Schmidt, with examples of various cases which have occurred in practice. The discussion of the whole subject is made from the standpoint of the railway engineer, especially with regard to reconstruction work upon locations where landslides have taken place, and hence is eminently practical in its nature.

Landslides occur because of the destruction of the equilibrium between the various masses of earth concerned, usually by reason of changes in the cohesion and frictional resistance originally existing. Since both the friction and the cohesion may be considered as passive forces, acting by resistance, the modification must come from some outside source. If, for example, we have a mass of earth more or less permeable by water, and resting upon an inclined stratum of non-permeable material, such as clay, we have all the elements for a landslide. From the action of moderate rains the upper stratum becomes soaked, the water which cannot pass through the clay forming a lubricating sheet between the two formations, and, as soon as a heavy rain comes, the whole upper mass slides, until a new position of equilibrium is attained. When the angle of the lower stratum is not greater than even the reduced angle of repose, the deformation occurs when the cohesion of the entire mass becomes unequal to sustaining the load upon it; hence we have two classes of disasters,—landslides proper, and failures from lack of cohesion. The principal cause of both kinds of failure is the presence of accumulated water, either in the form of ground water, rain, melting snow, or flood, and it is in connection with such conditions that the maxim of Sarilly applies: "The fear of clay and water is the beginning of wisdom."

In providing proper drainage to carry away the water which would otherwise accumulate at the dividing plane between the strata, numerous precautions are necessary, in order to insure prevention of sliding, and in the examples given both successful and unsuccessful constructions are shown. In one instance the construction of a cemented dam parallel with the railway on its upper side, with a longitudinal drain at its base, did not prove sufficient, although the dam was carried down below the level of the clay stratum; but the cutting of deep trenches at right angles to the roadway and about one hundred feet apart, forming cross drains filled with broken stone, relieved the accumulated water from surface drainage and from ground water sources, and provided effectually against further trouble.

In another case provision for underdrainage was made by the use of cast-iron-pipe drains, aided by auxiliary stone channels, a retaining wall being also provided at the base of the original slope. Although this answered for several years, a gradual sliding took place, which disturbed the continuity of the drains, and a rapid thaw, after a heavy winter, caused a serious landslide, which completely overwhelmed the retaining wall, and involved

the reconstruction of the work on a much more extensive scale. An entire regrading of the slope was made, and a new double retaining wall built, while several large masonry drains replaced the iron pipes giving full relief to the water and preventing the possibility of further accumulation.

It is impracticable, in the limited space here available, to give the details of these and other interesting examples contained in the paper, and for fully-illustrated accounts reference must be had to the original publication, which is worthy of the examination of the engineer who has to contend with similar problems. When the cost of proper protection against landslides is fully considered, however, Herr Soulavy maintains that it is cheaper and safer to build open viaducts in nearly all cases than to construct embankments and provide the necessary drainage tunnels and retaining walls.

A Swiss Compound Locomotive.

MORE than ten years ago the three-cylinder compound locomotives designed by Mr. Webb and built at Crewe for the London & Northwestern Railway were the subject of much interested discussion, and now we have a compound engine for use on the Simplon-Jura road in Switzerland, which, while similar in general appearance, is really just the reverse in arrangement and operation.

The Webb locomotive is made with two outside-connected high-pressure cylinders and one inside low-pressure cylinder, the outside connections being made to the rear axle and the inside cylinder connecting only to the forward cranked axle. There are no parallel rods, the relative positions of the pistons being controlled only by the steam distribution.

The new Swiss engine, as illustrated in the *Schweizerische Bauzeitung*, has one high-pressure cylinder inside, of 20.4 inches diameter, and two outside-connected low-pressure cylinders 21.25 inches bore, the three driving-axles being also connected by parallel rods, to which there is no objection in the mountain service for which the engine is intended, where a maximum speed of not more than 45 miles per hour is demanded. All three cylinders are provided with the Walschaert valve gear, so generally used in Switzerland and Belgium, and the boiler is intended to carry 200 pounds' pressure, an unusually large grate surface being provided in order to insure ample steaming capacity on the heavy grades.

By providing connections to enable the outside cylinders to be operated with high-pressure steam the engine is at once converted into a full-power simple locomotive, and in this manner ample starting power is obtained. When very heavy inclines occur, high-pressure steam can be used in all three cylinders, while for ordinary service an economical compounding is obtained by running the outside cylinders low-pressure with the steam from the single inside cylinder.

The total weight of the engine is 55 tons (metric), of which 44.5 tons rests on the six driving-wheels, and the success of the first of the design has been such that twenty-five engines of identical construction are now being built for use on the Bale-Delle section of the Simplon-Jura Railway.

An Important Power Plant.

THE company originally formed to exploit the distribution of compressed air in Paris has turned its attention largely to the generation and distribution of electricity, and has recently erected and equipped a large and important electric power plant on the Quai de Jemappes in Paris, of which a full account is given in *Le Génie Civil.*

Until recently the Paris company has been operating with a number of substations with transformers and accumulators, fed from two principal generating stations which furnished the high tension current. The expense for attendance which the maintenance of numerous sub stations involved has led to a rearrangement of the distribution system, and the result has been the construction of the fine new central power and electrical station to which reference has been made.

The site, close to the canal Saint-Martin, is rectangular, and covers an area of

nearly 60,000 square feet. This location is admirably adapted for the delivery of fuel,—which, when the station is running full, will amount to 140 tons per day,—and also provides an ample supply of water for condensing purposes.

The structure consists of a main central building containing the boilers, engines, and generators, with pavilions at each end for the auxiliary electrical apparatus and for the administrative offices.

The main building is arranged to contain the engines and generators in the lower portion, this part of the structure being of masonry, and carrying the boiler rooms, of iron and steel, above it.

The power house thus forms a rectangular hollow square, while in the central space, leaving sufficient room for light and air all around it, is an interior building containing the coal elevator, ash discharge, water connections and purifiers, and much of the auxiliary apparatus.

The power room proper is one of the largest yet in operation, containing twenty-three direct-connected engines and generators, each of 1,200 h. p., thus giving a total of 27,600 h. p., while in the room above are the boilers, arranged in groups of four for each engine. The engines are of the vertical compound Corliss type, with jet condensers, the cylinder ratio being 1 :2.84, for a boiler pressure of about 110 pounds. The boilers are of the Belleville water-tube type with automatic feed and attached super-heaters, each group of four boilers having its own sheet-iron chimney, 6½ feet in diameter and 65 feet high. Upon test, the steam consumption per i. h. p. was found to be 14.6 pounds per hour, including jacket supply and all other auxiliaries, this value being measured by the total steam delivered by the boilers.

The direct-connected dynamos are arranged normally to furnish each a current of 1,500 amperes at 500 volts tension, or 750,000 watts, although, if required, a tension of 600 volts can be supplied.

The electrical details of the plant are notable only because of the magnitude of the installation, but there are many details of the building and its contents which are of interest to the engineer. The constructive details are well shown by numerous sections and plans, while photographs of the work in course of construction show clearly the manner of building. The conditions of stability were especially well studied, and the distribution of the loads and the method of their support are discussed at length, so that the description of this work is available for use in connection with similar structures elsewhere.

The architectural portion of the work was in the hands of M. Friese, by whom all the structural computations were made, while the machinery was furnished by the Société Alsacienne de Constructions Mecaniques, the details, wiring, and general arrangements being made under direction of the engineers of the compressed air company. The entire work is important, both because of its magnitude and for the judgment and skill displayed in its design and execution.

The Magnetic Properties of Tempered Steel.

IT is not often that a scientific paper written by a woman is accepted for publication by the French Academy, but the recent memoir upon the magnetic properties of tempered steel, by Madame Sklodowska-Curie, which has been thus honored, is a thoroughly scientific investigation, and, in addition to the place in the *Comptes Rendus*, a more extended and original account of her work in this field is given in the *Bulletin de la Société d'Encouragement*.

The experiments were made upon selected bars of steel of various chemical composition from numerous sources, the specimens having been selected by Professor Le Chatelier, who also made a chemical analysis of each bar.

Each bar was magnetized to saturation, and determinations made of the coercitive field and the intensity of the remanent magnetism at the middle point. After having determined the properties of the various specimens, the following interesting and apparently original investigation was made. The bar of steel was placed in a porcelain tube heated by means of a

spiral of platinum wire traversed by an electric current. A double effect is thus produced; the current magnetizes the steel, and the heat raises its temperature. The magnetic condition can be continually investigated by a magnetic needle, and, when the temperature becomes sufficiently high, the bar is no longer magnetic. Now, Madame Sklodowska-Curie announces that the temperature at which the magnetic effect disappears is also the temperature which must be exceeded before the bar can be tempered. It thus follows that the steel can be tempered only after the magnetic transformation has taken place, when little or no magnetism exists in it.

Many of the details of the investigation are at present only of laboratory interest, but among the results of immediate practical value are those relating to the best percentage of carbon, and also those relating to the influence of other elements upon the suitability of the steel for permanent magnets.

So far as carbon is concerned, steels containing from 1.1 to 1.2 per cent. of carbon appeared to give the best results, while the presence of molybdenum or tungsten increased the coercitive effect, the highest effect being produced by 3.5 to 4 per cent. of molybdenum.

Investigations were also made upon the effect of repeated shocks, this being found to be less as the coercitive field is greater. The paper is a material addition to our knowledge of the conditions under which the best permanent magnetic effects can be produced, and, so far as such magnets are likely to be used in practical work, is of more than passing importance.

The New Collecting Sewer at Vienna.

A VERY important piece of municipal work at present under construction is the new collecting sewer on the right bank of the Danube canal, in Vienna, and a visit of inspection recently made by the Austrian Society of Engineers resulted in an interesting account of the works, published in the *Zeitschrift des Oesterr. Ing. und Arch. Vereines.*

The purpose of the sewer is to divert from the canal all offensive sewage and drainage, and to provide for the entire discharge of all the existing sewers of the city on the right bank, delivering the sewage into the Danube below the city. The large area thus drained includes many former streams which have been arched over in the built-up portion of the city. It would be impracticable to provide a collector of sufficient capacity to receive all the storm water in time of sudden and heavy rainfall, but this problem has been met by providing suitable overflow connections to the canal, which, coming into service only when the sewage is greatly diluted with rain-water, do not cause any perceptible nuisance.

The large size of the sewer, and the fact that its line lay directly through an important part of Vienna, introduced some difficult constructive problems, especially in connection with the underpinning of foundations of handsome and important buildings, the trench in some instances extending from curb to curb with a depth of 30 to 40 feet.

The soft nature of the soil in the open part of the excavation—soil which is practically the alluvium of the Danube—made it very necessary that the sides of the excavation should be most thoroughly braced, and the photographs of the work in progress show how great care was taken in this respect. In view of the character of the ground, pains were taken to insure a sufficient foundation for the masonry, piling being used where necessary, and the weight of the masonry being distributed by inverted arches upon concrete bedding.

The arch of the main subway is 24 feet span and 12 feet rise, with a channel 15 feet wide and 3 feet deep along the bottom, much as in the great Paris sewers, this leaving a footway along each side, by which the passage can ordinarily be traversed, while providing a large area above in times of emergency. Where the sewer is divided into two branches, as is the case just above the overflow at the Sofien bridge, the size is reduced in one case to 14 feet span by 10 feet rise, and in the other to 10 feet span by 7½ feet rise; in the latter case a portion of the work was

done by tunnelling, instead of opening a trench for the entire length. An interesting feature in connection with a portion of the tunnel work was the fact that the massive foundations of the old walls of Vienna lay in the path of the tunnel, and offered no small obstruction to the work.

An interesting feature in connection with the work is the extensive use of electric power for the removal of infiltrating water. Electric motors operating centrifugal pumps furnished a very satisfactory combination, the current being taken from the mains of the local electrical company, although in some cases portable steam engines and pumps were also used. The great convenience which the portable character of the electric motor and pump combination affords renders it especially adapted for contractor's service in work of this nature, there being eight electric motors used for this purpose and only two steam pumps.

The work upon the sewer was commenced only in September, 1897, and already more than one-third is completed, so that by the close of the present year this extensive municipal improvement will doubtless be an accomplished fact.

The Electrical Ignition of Fire-Damp.

A SERIES of very important investigations has recently been made in Germany by Messrs. Heise and Theim, and published in the *Elektrotechnische Zeitschrift*, upon the conditions under which fire-damp and coal dust in mines are ignited by the action of electrical apparatus. This is a matter of increasing importance, in view of the extending use of electrical machinery in mining work, not only for lighting purposes, but also for operating numerous forms of machinery. Generators, motors, drills, pumps, and similar electrical appliances are coming into general use, and the dangers from sparking, or from the possible production of high temperatures, such as overheated wires, short circuits, and the like, as well as the influence of exposed arcs or broken incandescent lamps, must all be taken into account in connection with the presence of explosive mixtures of gas and air.

A portion of the tests were made in a sort of wooden tunnel of elliptical section about 4 feet by 6 feet by 100 feet, while for some of the experiments a smaller chamber, with a capacity of about 350 cubic feet, was used. These chambers were made of wooden staves, hooped with T-iron bands; and safety windows covered with paper were provided, as well as heavy glass windows, for observation. The long chamber was partly buried in the earth, and by use of steam piping the temperature could be controlled in all weather. The gas tested was drawn from behind a bulkhead separating a gaseous working of the *Consolidation Brabauerschaft*, and a mechanical mixing apparatus insured a thorough mingling of the air and gas before testing. Fire-damp is explosive only when mixed with air in proportions between 5 1-2 and 14 1-2 per cent., the most violent explosions occurring when from 9 to 10 per cent. of methane is present; and, in order to make the tests cover the point of greatest risk, a mixture of 9 per cent. was employed. During prolonged tests samples of gas were drawn off from time to time and tested, thus avoiding the possibility of uncertainty on this point.

The first tests were made with exposed loops prepared by removing the bulbs from a number of incandescent lamps, the current being passed through until the loops became white-hot and finally burned off. Under these conditions the gas was ignited, but usually the explosion was deferred until the moment of breaking of the filament. Perfect lamps were then placed in the explosive mixture, and the bulbs broken, thus reproducing conditions which are apt to occur in practice.

The results of these experiments were somewhat varied, certain lamps failing every time to ignite the gases, while others as regularly proved dangerous. There seemed to be no difference in the action of continuous and alternating currents, and the different action of lamps made for use with various voltages seemed to indicate that it was the variation of current strength which caused the results observed. No explosions were caused by the breaking off of the nipple of the bulb, as

the gas entered slowly, and the filament burned out quietly.

Tests which were made with arc lamps showed that the arc was a very effective igniter of explosive gas mixture, but that it declined to explode either air charged with coal dust or a mixture of coal dust and air containing a small proportion of methane.

Very full experiments were made on all kinds of sparking connections, such as switches and dynamo and motor brushes, as well as fuses, with the result that all sparks were found to be an element of danger, although in some instances they failed to cause explosion.

In general, the experiments led to the following conclusions. Arc lamps should not be permitted in gaseous mains, nor should incandescent lamps be used with current above 0.6 ampere or voltage above 150 volts. Continuous current motors are apt to produce sparking, but three-phase motors with two brushes are safe. Switches should be enclosed, as should fuses also. Especial care should be given to all connections, and the greatest dangers appear to be due to the parting of connections for any reason, and the consequent production of arcs or sparking.

These investigations are really only preliminary, and should be considered as a foundation upon which to base other experiments; so considered, the work appears to have been well done, and the methods for future procedure appear to have been well marked out.

Electric Mountain Roads.

THE especial adaptation of electric power for the operation of mountain railways has gradually become recognized, and it is not at all unlikely that before long the trolley system will be the only one in use for these mountain-climbing roads. It is the overhead trolley which has been adopted for the road to the summit of the Jungfrau, now under construction, and a similiar system is intended for the rack railway projected between Chamounix and Montenvert. Quite in advance of these, however, is the electric rack railway from Zermatt to the Gornergrat, so well known to tourists for the magnificent panorama of the Southern Alps from Monte Rosa to the Matterhorn.

An excellent illustrated account of the construction of this new road, a portion of which has recently been completed, is given in *Le Génie Civil*, and both the electrical and the engineering features are worthy of attention.

Since 1891 a combined adhesion and rack railway has enabled the valley of Zermatt to be readily reached by travellers, but the ascent to the Gornergrat, over 10,000 feet above the sea-level, and more than 5,000 feet above Zermatt, has until now been reached only by climb afoot or on horseback.

As in the case of the Jungfrau road, the motive power is obtained from a mountain stream conveniently available, a head of over 300 feet being attained with an ample supply of water for the work to be performed during the few months which constitute the travelling season. The only points of novelty about the power plant are the ingenious devices to protect the machinery from injury by the possible sudden changes of load. Since it is quite possible that three fully-loaded trains may be thrown off at the same time, it is possible for the load upon the turbines to be varied from 0 to 500 h. p. within a few minutes. This is especially difficult to manage when the full load is thrown off, because the governor must check the water immediately to prevent the machinery from "running away," while the sudden check is likely also to produce violent water-hammer in the supply pipe. These requirements are met by a sensitive governor operating in connection with an air-compressor and reservoir of compressed air, which latter serves as a source of power for the prompt operation of the turbine gates, while the water-hammer is prevented by a relief valve, which is automatically opened whenever the turbine gates are suddenly closed, thus affording relief to the suddenly-checked water column. A sort of dash-pot connection permits this relief valve to close gradually soon after it has been opened, thus preventing any continuous

waste of water. Care is also taken to strain the water in order to insure the absence of *débris* which might find its way into the turbines and disable them.

A three-phase electric system is used with a frequency of 40 periods per second, the generators being of the well-known construction of Messrs. Brown, Boveri & Co. Like most mountain roads, the route of the railway line zigzags up the mountain side in a manner controlled by the grade and topography, but the feeders are much shorter than the railway, being carried directly across the loops in the route, and enabling three transforming stations to be fed with only about half as much length of conductor as would otherwise have been necessary.

The total length of the road is 5.7 miles, and the difference in altitude of the two stations 5,230 feet, or very nearly one mile; hence the average grade is 17.5 per cent. The steepest grade attained on the road is 20 per cent., near the summit.

The work includes four tunnels, of which the longest is 650 feet, several bridges, of which the most important is one at Visp about 90 feet long, and a viaduct over the Findelenbach, near the power house, consisting of three steel arches of 130 feet span each. The road is constructed on the Abt system, so generally used in Switzerland, and the work, as far as constructed, is of the most substantial character.

In the construction of the electric locomotive every care has been taken to secure ample power both for propelling and braking, two motors of 90 h. p. each being provided, each geared to a separate axle. The locomotive itself weighs 10.5 tons, and draws two cars, one open and the other closed, with a total capacity for 110 passengers, the entire estimated load being about 28 tons.

A portion of the road was completed before the approach of winter interrupted the work, and since November this has been under trial with satisfactory results. It is expected that the work will be completed in time for use by July of this year, thus making this the first mountain electric road on the triphase system.

Silico-Portland Cement.

THE questions of the importance of thorough admixture of the constituents of a cement mortar, and of the influence which the fineness of the sand has upon the resistance of the hardened material, have been discussed by several engineers, and investigated in the testing laboratories of Paris and Berlin.

A practical application of the knowledge thus acquired is seen in the works of the *Société des Ciments Français*, in the manufacture of what is termed Silico-Portland cement, a general account of which we take from *La Revue Technique*.

It has been found by experience that the diminution in strength shown by adding sand to neat cement is due both to the reduction in the proportion of cement in the mixture, and to the presence of voids between the particles, caused in part by the coarseness of the sand and in part by the fact that the sand and cement cannot be perfectly mixed in the preparation of the mortar, a sort of segregation taking place which results in weak spots and defective hardening.

The method of preparation consists in mixing one or two parts of sand with one of cement, and grinding the mixture to the degree of fineness usually given to the neat cement. The additional proportion of sand is then added, bringing the total to six parts of sand to one of cement, the difference being in the fact that a portion of the sand is so finely ground and so thoroughly mixed that it practically forms a portion of the cement and assists especially in filling the voids which otherwise would exist in the set and hardened mixture.

Tests which have been made with this simple modification of ordinary cement mortar show a large increase in strength and reliability, or—what is the same thing—a possibility of effecting a marked economy in cement for the same strength. A mortar consisting of silico-cement and sand corresponding to a proportion of 1 part of cement to 11 parts of sand gave under test a higher resistance than did a mixture of 1 part of cement to 3 parts of sand made in the ordinary manner.

THE ENGINEERING INDEX

INTRODUCTORY

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American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
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Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
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Electrical Engineer. *w.* New York
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Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
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Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
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Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
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Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash , D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
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Moniteur des Architectes. *m.* Paris.
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Municipal Affairs. *qr.* New York.
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National Builder. *m.* Chicago, Ill.
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North American Review. *m.* New York
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Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
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Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
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Railway Age. *w.* Chicago, Ill.
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Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
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Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York
Scientific Am. Supplement. *w.* New York
Scientific Machinist. *s-m.* Cleveland, Ohio.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill
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Trans. Am. Ins. Electrical Eng. *m.* New York.
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Trans. Am. Soc. Mech. Engineers. New York.
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Wiener Bauindustrie Zeitung. *w.* Vienna.
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Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
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ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Architectural Creation.

The Creation and Production of Architecture. George Aitchison. Presidential address delivered to students at the Royal Inst. of British Architects. Remarks on the causes of the great architectural epochs of Europe, the necessary requirements to produce fine architecture, and the aim of true architects. 2000 w. Brit Arch —Jan. 28, 1898. No. 18282 A.

Astoria Hotel.

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Beams.

See Civil Engineering, Miscellany.

Bracing.

Bracing in High Buildings. A. W. Barnes. Submitted to the International Convention of Building Commissioners and Inspectors, at Detroit. A discussion of the subject, and urging more uniformity in practice. 1600 w. Arch & Build—Feb. 12, 1898. No. 18345.

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Court Buildings.

The New Court Buildings in Munich. (Das Neue Justizgebäude in München.) General description, with plans, sections and photographs of this fine new government building. Three articles, three plates. 3500 w. Schweizerische Bauzeitung—Jan. 22, 29, Feb. 5, 1898. No. 18556 G.

Decoration.

The Evolution of Decorative Motives. A. D. F. Hamlin. Part first deals with the history and development of ornamental art, and the principles that control decorative composition. 3300 w. Am Arch—Jan. 29, 1898. Serial. 1st part. No. 18097.

Drawings.

The Drawings in the R. I. B. A. Students' Competitions. Ernest George. Critique on the designs and drawings submitted for the R. I. B. A. prizes and studentships. 2500 w. Brit Arch—Jan. 28, 1898. No. 18283 A.

Dwellings.

Designs for Popular Dwellings in Vienna. (Entwürfe für Volkswohnungen in Wien.) Giving the prize designs submitted in the recent Austrian Jubilee competition, for model dwellings to advance comfort and health. Serial. 1st part. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 11, 1898. No. 18543 B.

Fireproofing.

Effective Fireproofing. Describes a fire in a building for light manufacturing purposes, which, though lasting two hours, was confined to one floor by the fireproofing. 1500 w. Eng Rec—Jan. 29, 1898. No. 18150.

Fireproof Buildings. Edward Atkinson. A warning concerning the present construction of many steel- and iron-framed buildings, with report of the destruction by fire of a so-called "fireproof" factory in Burnley, Eng. Ill. 2500 w. Am Arch—Jan. 29, 1898. No. 18098.

Fireproof Construction of Domestic Buildings. Thomas Potter. Discusses means of fire protection for buildings used wholly or mainly for habitation. Also discussion. Ill. 12500 w. Jour Soc of Arts—Jan. 28, 1898. No. 18284 A.

The Construction of Slow Burning Buildings. Francis C. Moore. Especially devoted to such details of residence construction as affect the safety from destruction by fire. Formal specifications governing the most important features are given. 3500 w. Engineering Magazine—March, 1898. No. 18594 B.

Foundations.

Shoring the Walls of an Old Building. Illustrates method of carrying walls on small cylinder piers. 2500 w. Eng Rec—Feb. 5, 1898. No. 18217.

Substructure Work in an Office Building. Illustrated description of the unusual grillage foundations of the Singer Building, New York. 900 w. Eng Rec—Feb. 26, 1898. No. 18675.

Framework.

The Computation of the Upright Members of Iron Framework. (Die Berechnung der Ständer Eisener Wandfachwerke.) L. Geusen. An elaborate mathematical paper discussing the influence of wind pressures and other sources of lateral stress, and giving many diagrams of various constructions with their analyses. Two articles. 12000 w. Zeitschr d Ver Deu [illegible] Ing—Jan. 15, 22, 1898. No. 18547 G.

Monier System.

Calculations for the Monier System of Construction. (Zur Berechnung von Monier-Constructionen.) A. Ostenfeld. A mathematical treatment of the proportions of structures of the combined iron and concrete, including both beams and arches. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 14, 1898. No. 18501 B.

Park Building.

Corlears Hook Park Overlook. Illustrates

and describes a building 149 by 34 ft. for recreation and toilet purposes in a New York park. 1200 w. Eng Rec—Feb. 12, 1898. No. 18362.

Roof.

The Application of Link Connections to Roof Construction. (Der Anwendung von Gelenkträgern bei Dachkonstruktionen.) A discussion of the advantages of the link and pin connected system for roof trusses as compared with riveted construction. 1200 w. Schweizerische Bauzeitung—Feb. 5, 1898. No. 18558 B.

Steel Construction.

Two Questions in Connection with Steel Construction in Buildings. Edmund Burke. Read at the annual convention of the Ontario Assn. of Architects. The questions considered are protection from rust, and from high temperature caused by fire. Discussion. 5000 w. Can Arch—Feb., 1898. No. 18456 C.

HEATING AND VENTILATION.

Electric Heating.

A Survey of the Possibilities of Electric Heating and Cooking. W. P. Adams. Aiming to give a better understanding of the possibilities of electric heating. Part first deals with electric cooking, especially the cost. 1500 w. Elec, Lond—Jan. 28, 1898. Serial. 1st part. No. 18234 A.

Low Pressure.

Low Pressure Steam Heating Apparatus with Air Regulation. (Niederdruck Dampfheizung mit Ventil-Luft-Regulierung.) The Polle system provides an automatic method of admitting air into the radiators to reduce the temperature when it becomes too high. 1800 w. Gesundheits Ingenieur—Jan. 15, 1898. No. 18554 B.

School Ventilation.

Ventilation of a Washington, D. C., School. A description of the latest type of hot-blast heating installations. Ill. 1200 w. Eng Rec—Feb. 26, 1898. No. 18676.

Steam Injection.

Heating Water by the Direct Injection of Steam. An article in partial answer to queries received concerning the amount of coil surface, the best size of pipe, and time required to heat a given number of gallons of water through a given range of temperature. 1500 w. Locomotive—Jan., 1898. No. 18406.

Ventilation.

Study of Carbonic Oxid in Confined Air. (Recherche de l'Oxyde de Carbone dans l'Air Confiné.) Dr. Grehant. With an account of experiments upon animals showing the absorption of carbonic oxid by the blood, and also the production of carbonic oxid when air comes in contact with the metal of red hot stoves. 3000 w. Le Génie Civil—Jan. 8, 1898. No. 18506 D.

LANDSCAPE GARDENING.

School Gardens.

School Gardens. Henry Lincon Clapp. Describes the school gardens of many parts of Europe, discusses their educational value, and suggests their general adoption in the United States. Ill. 3800 w. Ap Pop Sci M—Feb., 1898. No. 18123 D.

PLUMBING AND GASFITTING.

Hospitals.

The Plumbing, Water Supply and Drainage of Hospitals. William Paul Gerhard. Reprint from the *Albany Medical Annals*. Calls attention to the matters of greatest importance. The necessity of plenty of light, fresh air and absolute cleanliness; discussing water supply, sewerage and plumbing. 13500 w. No. 18232 D.

Plumbing Law.

Ohio Plumbing Law Held to be Unconstitutional. The opinion of Judge Kohler, of the common pleas court of Salem County, Ohio, which declares the Ohio State law to be unconstitutional. 4500 w. Dom Engng—Feb., 1898. No. 18617 C.

Sacramento.

Plumbing Ordinance in Sacramento, Cal. A copy of an ordinance that has been in force more than a year. 3500 w. San Plumb—Feb. 15, 1898. No. 18476.

MISCELLANY.

Accounts.

Accounts for Architects. Henry Calder Marshall. Read before the Society of Architects, London. Shows the advantage of keeping proper accounts, and explains a simple system suitable for the profession of an architect. 3300 w. Arch, Lond—Feb. 11, 1898. Serial. 1st part. No. 18499 A.

Architects' Mortality.

Rate of Mortality Among Architects and Building Artisans. Lessons to be learned from the Blue Book by Dr. Tatham entitled "Supplement to the Fifty-fifth Annual Report of the Registrar-General of Births, Deaths, and Marriages in England." 2700 w. Builder—Feb. 5, 1898. No. 18391 A.

Architectural Development.

The Historical Development of Architecture. W. J. Anderson. Abstract of a course of lectures being delivered this Session before the Glasgow School of Art. Part first covers the first eight lectures. 2400 w. Jour Roy Inst of Brit Archs—Jan. 8, 1898. No. 18114 B.

Building Disaster.

The London Building Disaster. An effort to determine as nearly as possible the cause of the disaster at London, Ont., by which many lives were lost. 2700 w. Can Arch—Feb., 1898. No. 18455 C.

Competition.

The California University Competition. Editorial on this proposed international competition, giving an outline of the arrangements. 2300 w. Builder—Feb. 12, 1898. No. 18491 A.

The Phebe Hearst Architectural Competition for the University of California. Abstract of the programme with map. 3000 w. Jour Roy Inst of Brit Archs—Jan. 29, 1898. No. 18687 B.

Electrical Action.

Electricity in Modern Buildings. Considering whether there will take place any interaction between the steel framework and the electrical circuits which distribute the lighting and power currents. 1000 w. Can Elec News—Feb., 1898. No. 18363.

Fire and Water.

Fire-and-Water Resistance. Howard Constable. Extracts from a paper read before the Boston Society of Architects. On the necessity of further development in the direction of fire prevention. 2800 w. Am Arch—Feb. 19, 1898. No. 18615.

Glass.

Soluble Glass in House-Construction. C. Colné. On the properties, application and use of soluble glass, which is in favor in Europe. 2500 w. Am Arch—Feb. 12, 1898. No. 18356.

Hampton Court.

Hampton Court Palace. John Belcher. Read at meeting of the Architectural Assn., London. The building is considered from the architectural standpoint, giving history of the work from its beginnings. Discussion. 7800 w. Builder—Feb. 12, 1898. No. 18494 A.

Jews.

The Jews in Art and Architecture. Reviews the attitude of the Jews toward art in the earliest history and briefly traces the development. 1600 w. Stone—Feb., 1898. No. 18438 C.

London Fire.

The Cripplegate Fire and Its Lessons. Editorial on the reported investigations of a committee appointed to inquire into the possibilities of improvement in the burned district, in order to prevent a repetition of the catastrophe. 1800 w. Engng—Jan. 28, 1898. No. 18268 A.

Medusa.

The Medusa Myth in Greek Art. The extensive use of this emblem and the chief points of the story as illustrated in ancient art. 4500 w. Arch, Lond—Jan. 28, 1898. No. 18293 A.

Memoir.

The Late John Loughborough Pearson. An interesting sketch of the life of this noted architect and his most famous works. 3000 w. Jour Roy Inst of Brit Archs—Jan. 8, 1898. No. 18112 B.

Mosque.

The Great Mosque of the Omeiyades, Damascus. R. Phenè Spiers. Revised illustrations with explanatory notes. 2500 w. Jour Roy Inst of Brit Archs—Jan. 29, 1898. No. 18688 B.

Renaissance.

Humanist Architecture in England. Paul Waterhouse. Review of and abstracts from a recent book—"A History of Renaissance Architecture in England" by Reginald Blomfield, which is most favorably considered. Ill. 2400 w. Jour Roy Inst of Brit Archs—Jan. 8, 1898. No. 18113 B.

Renaissance Woodwork in England. J. Hungerford Pollen. Explains the meaning of the word "renaissance" and its application to the subject, discussing the work from the point of view of the architect. Discussion. 7000 w. Jour Soc of Arts—Feb. 11, 1898. No. 18495 A.

The Italian Renaissance. The first Royal Academy lecture on architecture this session, delivered by George Aitchison. Introductory remarks on early renaissance architects, and some of the work done by them. 3500 w. Builder—Feb. 5, 1898. No. 18392 A.

The Italian Renaissance. George Aitchison. The second Royal Academy lecture on architecture this session. Gives interesting description of examples with special attention to the Venetian Renaissance. 4500 w. Builder—Feb. 12, 1898. No. 18492 A.

The Italian Renaissance. George Aitchison. The third Royal Academy lecture on architecture this session. Deals with the Florentine Renaissance, the architects, buildings and many matters of interest. 3800 w. Builder—Feb. 19, 1898. No. 18733 A.

Scaffolding.

History of Early Scaffolding. W. J. Eden Crane. Reviews what is known of methods used in early times for the raising of high structures. Ill. 2000 w. Ill Car & Build—Feb. 18, 1898. No. 18689 A.

Theatres.

The Housing of the Drama. Edwin O. Sachs. Read at meeting of the Royal Institute of British Architects. Abstract. Treats of the aspects under which a playhouse devoted to the production of the drama could be constructed. Discussion. Ill. 3300 w. Builder—Feb. 12, 1898. No. 18493 A.

Training.

The Paris Training. John Galen Howard. A statement of what makes up the training in architecture in the course given in the Ecole des Beaux-Arts. 5500 w. Arch Rev—Vol. V.—No. 1. No. 18100 F.

Villa Fosca.

The Villa Fosca. Bertram Grosvenor Goodhue. An account of this interesting place on an island of the Adriatic. Part first is introductory, with some information of the gardens. Ill. 1100 w. Arch Rev—Vol V—No. 1. Serial. 1st part. No. 18099 F.

Wind Pressures.

The Measurement of Wind Pressures. Editorial on paper of Francis E. Nipher, communicated to the Academy of Science of St. Louis. 1200 w. R R Gaz—Feb. 25, 1898. No. 18666.

Wire Glass.

Recent Developments in the Manufacture and Applications of Wire-Glass. Francis Schumann. Its principal uses, and fire-resisting qualities. Ill. 1800 w. Jour Fr Inst—Feb., 1898. No. 18264 D.

Woodwork.

Polishes and Varnishes for Woodwork in Building. H. C. S. Gives ingredients and methods of preparation for a number of stains, varnishes, &c. 1200 w. Ill Car & Build—Jan. 28, 1898. No. 18235 A.

CIVIL ENGINEERING.

BRIDGES.

Bridges.

Three Noteworthy Foreign Bridges. (Drei Bemerkenswerthe Brückenbauten des Auslandes.) M. Foerster. A descriptive comparison between the Franz-Josephs Bridge at Budapest, the Alexander III Bridge at Paris, and the new arch bridge at Niagara. 4500 w. Stahl und Eisen—Feb. 1, 1898. No. 18571 D.

Caisson.

Pneumatic Caisson, Alexander III. Bridge. Condensed from the Paris *Génie Civil*. Describes the erecting and sinking of probably the largest caisson ever used. 900 w. Eng Rec—Feb. 26, 1898. No. 18671.

East River Bridge.

New East River Bridge. Important details and portions of the specifications for the bridge to be built between Delancey Slip, New York, and South Fifth Street, Brooklyn. 1500 w. R R Gaz—Feb. 11, 1898. No. 18330.

The Towers and End Spans for the New East River Bridge. Illustrations reproduced from the engravings accompanying the specifications from which selected information is given of interest in connection with the drawings. 3500 w. Eng News—Feb. 17, 1898. No. 18461.

Foundations.

The New East-River Bridge Foundations. Illustrates plant and methods of work. 2000 w. Eng Rec—Feb. 5, 1898. No. 18213.

Girder Riveting.

Field Riveting a Plate-Girder Span. Illustrates rapid methods of riveting with pneumatic tools, operated by a locomotive air-pump. 700 w. Eng Rec—Feb. 19, 1898. No. 18633.

Girders.

Plate-Lattice Girders. Discusses plate-lattice girders and compares them with the solid-sided girders, and doubts their being more economical. 2000 w. Engr, Lond—Jan. 21, 1898. No. 18115 A.

Portal Construction Applied to Girder Work. Illustrates a novel Belgian bridge. 1100 w. Feb. 26, 1898. No. 18669.

Park Bridges.

Cleveland Park Bridges. Illustrates and describes the new bridges which were designed with a special view to æsthetics. 1200 w. Eng Rec—Feb. 26, 1898. No. 18667.

Viaducts.

The Masonry of the New Viaducts over the Seine. (Exécution de Maçonneries des Nouveaux Viaducs sur la Seine.) Description of the new bridges over the Seine on the line of the Western Railway of France between Paris and Havre, with especial reference to the piers of truss bridges and the masonry work of stone arches as well as pneumatic foundations. Two articles, two plates. 6000 w. Le Génie Civil—Jan. 8, 15, 1898. No. 18505 G.

CANALS, RIVERS AND HARBORS.

Afflorestation.

The Significance of Afflorestation in Preventing and Correcting Torrents. F. Fankhauser. Address delivered before the Bern Forestry Assn. Considers forestation the only lasting remedy, the one nature herself applies when not interupted by man, and discusses the subject in full. 3300 w. Indian Forester—Dec., 1897. No. 18206 D.

Aqueduct.

Reconstruction of the Hessen Aqueduct. Illustrated account of the substitution of structural work for heavy masonry construction in Alsace-Loraine. 800 w. Ry & Engng Rev—Feb. 12, 1898. No. 18364.

Canal Depth.

The Economic Depth for Canals of Large Traffic. Joseph Mayer. Showing that the question has not been settled, and noting the points needing to be determined before it can be decisively answered. 4400 w. Pro Am Soc of Civ Engs—Feb., 1898. No. 18645 F.

Dams.

Movable Dams. B. F. Thomas. Valuable information on this subject with a description of the needle dam recently completed on the Big Sandy River at Louisa, Ky., and urging the construction of movable dams of higher lift on American rivers. Ill. 57500 w. Pro Am Soc of Civ Engs—Feb., 1898. No. 18646 F.

Drainage.

The Drainage Works of the Delta of the Niemen. (Travaux d'Epuisement du Delta du Niemen.) An illustrated account of the steam and electric drainage plant. Power is distributed electrically to a number of points where electric motors operate large scoop wheels. 3500 w. Le Génie Civil—Jan. 29, 1898. No. 18512 D.

Dredging.

Cost of Dredging in the United States. Tables compiled for the Nicaragua Canal Commission by T. Jenkins Hains. Also Cost of Concrete in the United States. 2500 w. Eng News—Feb. 17, 1898. No. 18458.

Dry-Docks.

The Brooklyn Dry-Dock Failure. A history of the dock which failed to hold water. 2000 w. Eng Rec—Feb. 19, 1898. No. 18632.

Erie Canal.

The Future of the Erie Canal. Explains the legal aspect of canal improvements. 700 w. Eng Rec—Feb. 5, 1898. No. 18212.

Harbor Improvements.

Harbor Improvement and Water Service at Portsmouth, Eng. The proposed improvement of the harbor railway terminus and the establishment of a better service by water between Portsmouth and Gosport. 1800 w. Transport—Feb. 4, 1898. No. 18389 A.

The Harbor Works at Fraserburgh. Describes

a scheme of harbor development and extension now in progress at this point. Ill. 3000 w. Transport—Jan. 21, 1898. No. 18158 A.

Naval Civil Engineers.

Some Lessons of the New York Naval Dry-Dock Failure. An editorial on the difficulties under which the naval civil engineers work. 2000 w. Eng Rec—Feb. 12, 1898. No. 18358.

The Bureau of Yards and Docks, U. S. Navy Department. An editorial explanation of the cause of poor civil-engineering work in the navy yards. 1000 w. Eng Rec—Feb. 19, 1898. No. 18630.

N. Y. State Canals.

The Condition of the New York State Canals. Illustrates the old and new work. 500 w. Eng Rec—Jan. 29, 1898. No. 18146.

River Banks.

The River Bank Protection Works for the Bukowina Local Railway. (Die Uferschutzbauten bei den Bukowinaer Localbahnen.) R. Ziffer. An excellent account of the effective methods used for protecting the banks of mountain torrents in the Carpathians. Two plates. 2000 w. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1898. No. 18561 D.

River Improvement.

The Proposed Improvement of the Mouth of the Mississippi. From the New Orleans *Daily Picayune*. Abstract of arguments submitted by committee in connection with a proposed deeper channel at the entrance of the river. 900 w. Eng News—Feb. 24, 1898. No. 18656.

Ship Canal.

The Opening of the Ship Canal through Breslau, and the Canalisation of the Upper Oder to Kosel. (Die Eröffnung des Grosschiffahrtsweges durch Breslau und die Canalisirung der Oberen Oder bis Kosel.) With maps showing the location of the work and data concerning its commercial importance. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 4, 1898. No. 18542 B.

Towing.

Cable Towing. (Halage Funiculaire.) A brief abstract of the application of continuous cable towage on the Aisne and Marne Canal, in the north of France. 1200 w. Comptes Rendus—Jan. 10, 1898. No. 18518 D.

IRRIGATION.

India.

The Palar Anicut System. General plan of the head works and a cross-section of the Anicut, giving particulars of interest to the irrigation engineer. 900 w. Ind Engng—Dec. 25, 1897. No. 18111 D.

Water-Rights.

The Adjudication of Water-Rights in Irrigated Regions. Elwood Mead. Discusses the differences in ownership between water-rights and other property, and advocates individual operation under public ownership as the solution of the problem. 4000 w. Engineering Magazine—March, 1898. No. 15898 B.

MISCELLANY.

Ancient Engineers.

The Engineers of the Past. Perry F. Nursey. A brief comparison and review of the works of the ancient engineer. 1800 w. Ind & Ir—Feb. 11, 1898. No. 18485 A.

Beams.

The Efficiency of Built Up Wooden Beams. Edgar Kidwell. The experiments described were made in the mechanical laboratory of the Michigan College of Mines, with the object of obtaining data upon the relative efficiency of various forms. Ill. 19000 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18475 D.

The Flexure of Thick Beams. (Sur la Flexion des Pièces Epaisses.) M. Ribière. A mathematical discussion, showing that when the depth of a beam is greater than one-tenth of its length, the stresses at various points of the section depart from the usual trapezoidal law, and are indicated by curves rather than straight lines. 1800 w. Comptes Rendus—Jan. 31, 1898. No. 18525 D.

Cement.

Portland Cement Tests from the Manufacturer's Point of View. John W. Dickinson. On the value of testing and some of the methods, and its importance to the reliable manufacturer. 1400 w. Munic Engng—Feb., 1898. No. 18122 C.

Silico-Portland Cement. (Le Silico-Portland ou Silico-Cement.) A fully illustrated article upon the manufacture of the improved cement in which a portion of finely ground sand is mixed with the cement. The strength is greatly increased by the more intimate union of the constituents. 5000 w. La Revue Technique—Jan. 25, 1898. No. 18526 D.

The Hardening Process of Calcareous Hydraulic Cements. W. Michaelis. Read before the Society for the Unification of Methods of Testing Technical Materials at Stockholm. A careful study of the process of hydraulic hardening. 4200 w. Engng—Feb. 4, 1898. No. 18373 A.

The Proper Manipulation of Tests of Cement. A copy of questions sent out by committee appointed to report on this subject. 7200 w. Am Arch—Feb. 19, 1898. No. 18616.

Corrosion.

The Corrosion of Iron in Concrete. A summary of information that has been published on this subject. Part first gives abstract of paper by G. Bouscaren on the Covington and Cincinnati suspension bridge, and also of the discussion. 2500 w. Eng Rec—Feb. 19, 1898. Serial. 1st part. No. 18634.

The Corrosion of Iron in Concrete. A symposium on the subject by several engineers and architects, in continuation of information given in this paper, Feb. 19. 1100 w. Eng Rec—Feb. 26, 1898. No. 18668.

Framework.

See Architecture and Building, Construction.

Landslides.

See Railway Affairs, Permanent Way.

Monier System.

See Architecture & Building, Construction.

Netherlands.

Engineering in The Netherlands. H. A. Van Ysselsteyn. Historical and descriptive account of machinery used for keeping dry the lands lying lower than the surface of the sea. Ill. 2000 w. Power—Feb., 1898. No. 18200.

Roads.

A Few Things to be Remembered in Building Good Roads. William H. Barnes. The importance of good drainage and having the bed well prepared, pointing out some of the more common faults in road building. 1700 w. Stone —Feb., 1898. No. 18439 C.

New Jersey State Roads. A review of the successful and satisfactory law regulating state road-work. 2000 w. Eng Rec—Feb. 19, 1898. No. 18636.

Roof.

See Architecture & Building, Construction.

Shield Tunneling.

Shield Tunneling for the Boston Subway. Illustrates in detail the operations involved in constructing this hydraulic roof-shield. 900 w. Eng Rec—Feb. 26, 1898. No. 18670.

Steel Construction.

See Architecture & Building, Construction.

Surface Drainage.

Dimensions of Channels for Surface Drainage. Charles Edward Livesay. Reprinted from the Minutes of Proceedings Inst. C. E. Formulates a theory and describes its application in actual practice in India. 5000 w. Engng—Feb. 11, 1898. No. 18481 A.

Surveying.

Dialling Troubles and Their Treatment. Arthur Mort. Remarks on the troubles which beset the dialler in his work. 1500 w. Col Guard —Jan. 21, 1898. No. 18140 A.

Telemeters.

A Diagram for the Reduction of Telemeter Readings. Neville B. Craig. States facts showing the difficulty and labor of all methods of obtaining accurate results in topographical work, and explains the use of a diagram, constructed by the writer, which has given more satisfactory results than any device he has tried. It is simple, rapid and comparatively inexpensive. 2000 w. Eng News—Feb. 3, 1898. No. 18202.

Timber Preservation.

The Haskin Process of Preserving Timber. Account of the plant and description of process. Ill. 2400 w. Engr, Lond—Jan. 28, 1898. No. 18276 A.

Time.

The System of Decimal Time. (Sur la Système de l'Heure Decimale.) An abstract of a report upon the decimal subdivision of the hour, with its relations to the divisions of the day and the circle, presented to the French Academy by M. D. Sarranton. 1500 w. Comptes Rendus—Jan. 17, 1898. No. 18520 D.

Wind Pressures.

See Architecture & Building, Miscellany.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Commerce.

Our Foreign Business in 1897. Facts taken from the import and export returns published by the United States Bureau of Statistics. 1400 w. Ir Age—Feb. 24, 1898. No. 18640.

The Foreign Commerce of the United States in 1897. Table giving a summary of the imports and exports by customs districts for all ports where the volume of either incoming or outgoing business in 1897 was in excess of $400,000. 400 w. Eng News—Feb. 24, 1898. No. 18657.

Cheap Transportation.

Railroads versus Canals. J. A. Latcha. Arguments against canal building, especially the Nicaragua canal, and urging the development of railroads, and lessening the cost of operation, enabling the commodities of the United States to be delivered in Europe and Asia, at prices that would undersell the world. 7500 w. N Am Rev—Feb., 1898. No. 18183 D.

China.

America's Interests in China. James H. Wilson. Some information of the country, people, and government given to make clear the commercial and diplomatic interests of the United States. 5000 w. N Am Rev—Feb., 1898. No. 18181 D.

Great Britain's Opportunity in China. C. A. Moreing. On the decision of the British Government to guarantee a loan of £12,000,000 sterling to China, at 3 per cent. interest and the importance of the event. The terms are discussed. 3200 w. Nineteenth Cent—Feb., 1898. No. 18425 D.

Our Trade with Western China. John Foster Fraser. The writer is one of the three cyclists who have crossed China from Burma to Shanghai. Matters concerning British trade and the best points for its introduction. 2800 w. Contemporary Rev—Feb., 1898. No. 18287 D.

United States Trade with China. Additional details relating to Kiao-Chow Bay. Also table showing that the United States trade has made great advancement. 600 w. Cons Reps—Feb. 5, 1898. No. 17706 D.

Eastern Trade.

German versus British Trade in the East. Clavell Tripp. Considers the British need have no fears in regard to retaining their commercial supremacy, giving reasons based on personal experience during long residence in Sumatra. 2200 w. Nineteenth Cent—Feb., 1898. No. 18423 D.

Germany's Trade with Eastern Asia. Infor-

mation of German exportation during 1896. 400 w. Cons Reps—Feb. 10, 1898. No. 18341 D.

Opportunities in the East. Editorial discussion of the openings for trade and industry in Japan and China. 1200 w. Mach, Lond—Feb. 15, 1898. No. 18648 A.

Economic Changes.

The Distribution of Manufacturing Industries. Calls attention to changes in progress due to modern inventions and the spread of civilization, carrying manufacturing industries all over the world, tending to bring together the factory and the raw material and diminishing local advantages. 1700 w. Eng News—Feb. 10, 1898. No. 18321.

Free Trade.

The Manchester School and To-Day. Andrew Carnegie. Explains the position as outlined by the Manchester School, and the changed conditions, and development of the industrial world. 3000 w. Nineteenth Cent—Feb., 1898. No. 18424 D.

German Exports.

German Exports to the United States, 1897. A comparative statement of the exports during 1896 and 1897. 1200 w. Cons Reps—Feb. 19, 1898. No 18606 D.

Great Lakes.

Commerce of the Great Lakes. The development of trade on the great American lakes, the works of improvement in facilities for travel, and the immense traffic. 1800 w. Sci Am—Feb. 19, 1898. No. 18418.

Japan.

Japanese Trade with Britain. Gives some suggestions of Mr. Arakawa, the consul for Japan in London, made to indicate how the Japanese may improve their conditions of trade. 700 w. Engng—Feb. 11, 1898. No. 18478 A.

The Condition of Trade with Japan. Editorial on the report of Bryan Brenan, who was sent to investigate the condition of trade. 2300 w. Engng—Jan. 28, 1898. No. 18267 A.

The Shipping Industry in Japan. Editorial on the condition of this industry with criticism of the methods of doing business. 1500 w. Engng—Jan. 21, 1898. No. 18132 A.

Omaha Exposition.

The Great Exposition at Omaha. Charles Howard Walker. The plan of the grounds, character of the buildings, and matters of general interest. Ill. 2000 w. Century Mag—Feb., 1898. No. 18124 D.

Prices.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Tabulated statements, showing fluctuations in quotations from Jan. 1, 1895, to Feb. 1, 1898. 20000 w. Bradstreet's—Feb. 12, 1898. No. 18355.

What Determines Prices? Considers different theories of value, and defends the doctrine that economic value is determined by the cost of production rather than by the mere ratio between supply and demand. 3000 w. Gunton's Mag—Feb., 1898. No. 18209 C.

Rubber.

Has There Been Speculation in Rubber? The opinions of rubber men on this subject, suggested by the persistency with which the prices of crude rubber rise in the face of a full production. 2500 w. Ind Rub Wld—Feb. 10, 1898. No. 18430 D.

The Crude India-Rubber Trade of 1897. Statistics for the year are given with comments. 1200 w. Ind Rub Wld—Feb. 10, 1898. No. 18431 D.

Russia.

Russian Industry and Trade. Calling attention to the economic and industrial development which is taking place in this country. 1800 w. Engng—Feb. 4, 1898. No. 18372 A.

The Influence of the Great Siberian Railway upon Russian Industries. The outlook resulting from the development of the vast resources of Siberia, and their importance to the United States. 1100 w. Ir Age—Feb. 10, 1898. No. 18315.

Trade with Russia. Editorial review of Mr. Mitchell's opinions concerning the industrial resources and prospects of the Russian Empire. 1000 w. Mach, Lond—Feb. 15, 1898. No. 18649 A.

Statistics.

Credit and Trade. A. Sauerbeck. A review of the position of credit and trade during the past year, largely confined to British interests. 3500 w. Bankers' Mag, Lond—Feb., 1898. No. 18426 F.

Credit and Trade in the United States and Canada. A review of the past year. 1800 w. Bankers' Mag, Lond—Feb., 1898. No, 18427 F.

World's Commerce.

A French View of the World's Commerce. Statement made by Jules Roche, in an address to a conference of the merchants and bankers of Lyons, Fr., regarding the importance, as exporters of England, Germany, the United States, and France. 300 w. Cons Reps—Feb. 8, 1898. No. 18233 D.

CURRENCY AND FINANCE.

Currency.

Currency Reform. Robert S. Taylor. States the declaration of principles of the Indianapolis convention, the events that led to this action, and the work of the Monetary Commission. 3400 w. Century Mag—Feb., 1898. No. 18126 D.

The New Indian Currency Measure. Reviews the steps already taken by the India Government in the direction of currency reform, and considers the measures recently proposed by the Council. 2500 w. Bankers' Mag, Lond—Feb., 1898. No. 18428 F.

Monetary Commission.

The Monetary Commission and Its Work. Charles S. Fairchild. An account of the conditions that caused the appointment of this commission, the work done, and the points considered. 5000 w. N Am Rev—Feb., 1898. No. 18182 D.

Russia.

The Gold Standard in Russia. Reprint of an article in a Russian paper regarding the change in Russia's currency. 800 w. Cons Repts—Feb. 10, 1898. No. 18342 D.

GOVERNMENTAL CONTROL.

Commerce Regulation.

The Proposed Changes in the Law to Regulate Commerce. Milton H. Smith. The objections of the writer to the proposed changes relating to the long and short haul. Also editorial. 3000 w. Ry & Engng Rev—Feb. 19, 1898. No. 18629.

See Railway Affairs, Legal.

Municipal Ownership.

See Street & Electric Tramways.

Ownership.

See Railway Affairs, Legal.

Protection.

Equitable Protection. Debate between David Lubin and John E. Russell before the New England Free Trade League. 12500 w. New Eng Free Trd League, Boston—No. 7 of 1897. No. 18429 D.

Socialism.

See Electrical Engineering, Lighting.

LABOR.

Compensation.

Compensation to Workmen. A. D. Provand. Gives a brief history of what has been done in England to compensate workmen for injuries sustained. Discussion. 8500 w. Jour Soc of Arts—Feb. 11, 1898. No. 18496 A.

Workmen's Compensation Act and Employers' Liability. Discussion of a new Act which will come into operation in England, July 1, 1898. Gives a summary of the Act with explanations and comments. 6300 w. Ill Car & Build—Jan. 28, 1898. No. 18236 A.

Engineering Strike.

Some Lessons of the Great Strike. Considers that the men should be taught the need of moderation, of wise leadership, of a wider outlook, of securing public sympathy; that the employers should be taught the need of up-to-date systems of working, of moderation, and of better relationships with their workers. 2800 w. Elec, Lond—Feb. 4, 1898. No. 18336 A.

The Crisis in the Engineering Dispute. Editorial on the apparent approaching end of this labor struggle, showing the present attitude of masters and men. 3000 w. Engng—Jan. 21, 1898. No. 18133 A.

The End of the War. Remarks on the apparent defeat of the Amalgamated Society of Engineers, and on the mistakes made and changes required. 3000 w. Engr, Lond—Jan. 28, 1898. No. 18277 A.

The Resumption of Work. Editorial on the conditions the workmen must meet on their return to work. 1800 w. Engng—Feb. 4, 1898. No. 18371 A.

Exhibits.

Social Economy Exhibits at Brussels. This class of exhibits comprised all that relates to teaching and apprenticeship, the organization of labor, the safeguarding and regulation of labor, labor economics, &c., &c. An account of some of the exhibits is given in part first. 2000 w. Engng—Feb. 4, 1898. Serial. 1st part. No. 18369 A.

Immigrant.

A Typical Alien Immigrant. Arnold White. A reply to an article in the last number of this magazine, by John A. Dyche. 4600 w. Contemporary Rev—Feb., 1898. No. 18288 D.

Labor Discussion.

The Engineers' Dispute. Reports a discuscussion of the recent strike and lockout in England, at a gathering of the members of the United Club, held at the Criterion. 4500 w. Engr, Lond—Feb. 11, 1898. No. 18483 A.

Labor Statistics.

Recent Foreign Labor Statistics. Brief report of items, selected from various sources, relating to the labor conditions of the Netherlands, France, Belgium, and Russia. 1800 w. Gunton's Mag—Feb., 1898. No. 18210 C.

Prison Labor.

Labor in Russian Prisons. C. D. Randall. Some information of prison life in Russia, including Siberia. 2200 w. State's Duty—Jan., 1898. No. 18127.

Protection.

Labor's Interest in Protection. Henry Smith Robinson. Shows what would be the effect of adopting free trade, and that protection is necessary to the prosperity of the laborer. 2500 w. Gunton's Mag—Feb., 1898. No. 18208 C.

Trade Unions.

Trade Unions in 1896 Interesting information culled from the Ninth Report on Trade Unions in Great Britain. 1800 w. Jour Gas Lgt—Feb. 8, 1898. No. 18440 A.

MISCELLANY.

Discontent.

Some Pressing Problems. A. H. McKnight, Notices the tariff, ownership of land, the monetary system, socialism, &c. 2300 w. Gunton's Mag—Feb., 1898. No. 18211 C.

Education.

Technical Education in Sweden. (Das Technische Unterrichtswesen Schwedens.) Th. Beckert. A very full account, showing the extent and high character of the technical educational work done in Sweden and Norway. 7500 w. Zeitschr d Ver Deutscher Ing—Feb. 5, 1898. No. 18552 D.

England.

England's Economic and Political Crisis. J. N. Larned. An interesting study of the conditions which have affected the development of England, and the causes that have operated to diminish the economic capability in production and trade. 8500 w. Atlantic M—March, 1898. No. 18608 D.

Fish Products.

Oil and Guano from Fish. (L'Huile et le

Guano de Poisson.) Discussing the technological applications of fish oil, and the use of the residues as a fertilizer. 2000 w. Le Génie Civil—Jan. 1, 1898. No. 18504 D.

Patents.

Prior Foreign and Later United States Application for Patent on the Same Invention. D. Walter Brown. Discussing the amendments to the patent statutes that went into effect Jan. 1, 1898, in the United States. 700 w. Am Mach—Feb. 17, 1898. No. 18435.

The Important Features of the New Austrian Patent Law. (Die Wichtigsten Bestimmungen des neuen Oesterr. Patent-Gesetzes.) An abstract of the salient features of the law of January 11, 1897, referring both to patents and trade marks. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 29, 1898. No. 18575 B.

Prizes.

Programme of Prizes Offered by the French Academy. (Programme des Prix Proposés pour les Années 1898, 1899, 1900, et 1901.) Giving the value and conditions of competition of the many prizes offered by the French Academy for the next four years in various departments of scientific research. 10000 w. Comptes Rendus, Jan. 10, 1898. No. 18519 D.

Silk.

Silk and Silk-Worms in China. A report upon silk cultivation and preparation, and upon the raising and care of silk-worms as conducted in the province of Szechuen. 2000 w. Cons Repts—Feb. 21, 1898. No. 18607 D.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Bleaching.

The Electrolytic Decomposition of the Chlorides of Sodium and Magnesium. M. C. Beebe. Abstract of a thesis submitted at the Univ. of Wisconsin. Also editorial. An account of investigations and experiments to ascertain under what conditions a bleaching solution can be economically prepared, and thus determining whether electrolytic bleaching can compete with the chemical methods. 6500 w. Elect'n, Lond—Jan. 21, 1898. No. 18110 A.

Electrolysis.

Concerning Hydrolysis and Catalysis. (Ueber Hydrolyse und Katalyse.) G. Platner. Discussing the experiments of Warburg, Paschen, and Jahn, concerning the hydrolytic dissociation of various salts. 3000 w. Elektrochemische Zeitschr—Jan., 1898. No. 18587 D.

Ore Treatment.

Notes on the Electro-Chemical Treatment of Ores Containing the Precious Metals. C. E. Webber. Read before the British Institution of Electrical Engineers. Historical review of the various known processes is given in part first. Ill. 2400 w. Ind & Ir—Jan. 28, 1898. Serial. 1st part. No. 18280 A.

Progress.

Electro-Chemistry's Advance. Inaugural address of J. W. Swan before the British Inst. of Elec. Engs., on the progress of electro-chemistry and the industries and applications. 3000 w. Engng—Jan. 21, 1898. Serial. 1st part. No. 18142 A.

Review.

Electrochemistry in 1897. (Die Elektrochemie im Jahre 1897.) Dr. H. Weyer. A very full review of the progress of electro-chemistry during the past year, with numerous references to periodical literature. 6000 w. Elektrochemische Zeitschr—Jan., 1898. No. 18588 D.

White Lead.

Some Electrolytic Processes for the Manufacture of White Lead. Sherard Cowper-Coles. Describes the Dutch process, which is still considered the best as regards its covering capacity and also describes briefly several electrolytic processes. 1300 w. Elec Rev, Lond—Feb. 11, 1898. No. 18487 A.

Zinc.

Electrolytic Zinc. A review of the processes used and comments on the cost. 1200 w. Engng—Jan. 21, 1898. No. 18136 A.

LIGHTING.

Baltimore, Md.

The System of the Brush Electric Company of Baltimore. Illustrated description of the rebuilt station, which is one of the most complete and systematically arranged in the country. 1300 w. Elec Wld—Feb. 26, 1898. No. 18624.

Carbons.

Carbons for Electric Lighting and Other Purposes. Francis Jehl. From a forthcoming book to be published by the *Electrician*. Part first considers the physical properties of carbon, and gives historical notes on uses. 3000 w. Elect'n, Lond—Feb. 4, 1898. Serial. 1st part. No. 18401 A.

Fluorometer.

The Fluorometer. Describes and illustrates an instrument used to establish with precision the location of any foreign object within the human organism, which is comparatively impermeable to the X-rays. 1500 w. Sci Am—Feb. 12, 1898. No. 18307.

Generating Unit.

A Compact Electric Generating Unit. Illustrated description of a machine just installed in the Twelfth Street Station of the Edison Electric Illuminating Co., New York. 2000 w. Power—Feb., 1898. No. 18199.

Glow Lamps.

Experiments on the Glow Lamp. Hiram S. Maxim. From London *Lightning*. On the experiments of the writer who claims that he can save from 25 to 33 per cent. 800 w. Elec Rev, N. Y.—Feb. 2, 1898. No. 18168.

House Wiring.

Technical Litigation and the Question of Good Work in House Wiring. V. Zingler. Part first considers technical litigation demonstrating that the law is not a fit or proper instrument for deciding these cases on their merits, nor the Law Courts the place for referring the cases. 2000 w. Elec Rev, Lond—Jan. 28, 1898. Serial. 1st part. No. 18290 A.

Nottingham.

Nottingham Electricity Works. Illustrated detailed description. 2200 w. Elec Eng, Lond—Feb. 11, 1898. No. 18488 A.

Socialism.

Municipal Socialism. Fred. De Land. Read before the Northwestern Electrical Assn. Statements concerning electric lighting in Des Moines, Ia., also in Detroit, Topeka, and Allegheny City, and an examination of the question whether the mayor of the first named city was justified in fixing $75 per year for each arc lamp of 2000 candle power. 1600 w. Elec Eng, N. Y.—Feb. 10, 1898. No. 18306.

Stage Lighting.

The Switchboard for Stage Lighting. H. Bissing. Some suggestions of points worth considering in the arrangements for stage lighting. 800 w. Elec Wld—Feb. 19, 1898. No. 18422.

Station Destroyed.

Destruction of an Electric Lighting Sub-station in Montreal. An account of the destruction of the sub station at Côte Ste. Paul, Montreal, belonging to the Lachine Rapids Hydraulic and Land Co. Ill. 500 w. Elec Wld—Feb. 19, 1898. No. 18421.

Wiring.

Interior Wiring. Charles E. Knox. Part first is introductory presenting and discussing the methods and practices in vogue at the present day. The serial will include detailed plans for wiring all classes of buildings. 2500 w. Am Elect'n—Feb., 1898. Serial. 1st part. No. 18242.

Merchant-Marine Wiring. E. W. Countiss. Pointing out the precautions that must be taken to avoid fire risks. Ill. 1500 w. Am Elect'n—Feb., 1898. No. 18243.

POWER.

Boosters.

See Street and Electric Tramways.

Central Stations.

Topics of Interest to Central Station Men. F. B. Badt. Address delivered before the Northwestern Elec. Assn., Milwaukee. Discusses 220-volt lamps, enclosed arc lamps, alternating system, etc. 2200 w. W Elect'n—Jan. 29, 1898. No. 18153.

Coal Mining.

See Mining and Metallurgy, Coal and Coke.

Compound Dynamos.

The Parallel Operation of Compound Dynamos. George T. Hanchett. Explains an arrangement for overcoming the difficulty arising in the operation of compound dynamos in multiple because of their failure to regulate for line loss with accuracy. Ill. 1100 w. Elec Wld—Feb. 12, 1898. No. 18303.

Electricity in Mills.

Electricity in Cotton Mills. A letter from W. B. Smith Whaley on the advantages of electric operation. 1200 w. Eng Rec—Feb. 12, 1898. No. 18361.

Electric Lifts.

Electric Lifts and Cranes. Abstract of the discussion of a paper by H. W. Ravenshaw, read at meeting of British Inst. of Civ. Engs. 7000 w. Col Guard—Jan. 21, 1898. Serial. 1st part. No. 18139 A.

Electric Motors.

The Electric Motor at Home. An illustrated account of a few of the uses made of these motors in the shops of the General Electric Company, at Schenectady, N. Y. 1500 w. Ir Age—Feb. 3, 1898. No. 18171.

Electric Welding.

The Electrically Welded Rail. Hunter Morrison. Brief historical review of this work, with table showing energy absorbed in electric welding. Ill. 1200 w. Yale Sci M—Jan., 1898. No. 18311 C.

Grain Elevator.

The Great Northern Elevator. Albert Vickers. Illustrated description of a fine, large grain elevator in Buffalo, N. Y., operated by electric power. 2500 w. Elec Wld—Feb. 12, 1898. No. 18302.

Locomotive.

See Railroad Affairs, Motive Power.

Montana.

The Montana Power Company. L. D. Tandy. Illustrated detailed description of a plant that will rank among the finest in the United States, from both an engineering and from a financial standpoint. 2000 w. St Ry Jour—Feb., 1898. No. 18194 D.

Motor Design.

Electric Motor Design for Ordinary Street Railways. E. C. Sickles. Considers some of the problems connected with the design of the electric motor for street-railway service. Part first gives a brief review of the main causes of present practice. 3800 w. Sibley Jour of Engng—Feb., 1898. Serial. 1st part. No. 18610 C.

Newspaper Presses.

Electrical Control and Operation of Newspaper Presses in the News and Record Office, Chicago. Describes the methods adopted. 1500 w. Elec Eng, N. Y.—Feb. 24, 1898. No. 18642.

Paper Making.

Use of Electric Motors in Paper Making. Louis Bell. Extract from a paper read before the New York meeting of American Paper and Pulp Assn. aiming to show the reduction in cost of power, and other advantages. 2000 w. Elec Wld—Feb. 26, 1898. No. 18625.

Power Development.

The Electric Development of Hydraulic Power.

F. C. Finkle. With especial reference to the development of water powers in southern California, giving many illustrations of power locations. 4000 w. Engineering Magazine—March, 1898. No. 18599 B.

Power Plant.

Hydraulic Electric Power at Moutier-Grandval, Switzerland. (Installation Hydro-Electrique de Moutier-Grandval, Suisse.) An interesting power plant near Basle. The flow of the river Birse is only about 21 cu. ft. per second, but a head of over 300 feet enables 500 h. p. to be developed and applied in this industrious community for lighting and power. 5000 w. 1 plate. Le Génie Civil—Jan. 1, 1898. No. 18503 D.

The Distribution of Electric Energy at Schwyz, Switzerland. (Distribution d'Energie Electrique de Schwyz.) An excellent account of this new power plant on the lake of Lucerne. Over 3000 h. p. are taken from the river Muota and distributed both for lighting and power. 1 plate. 5000 w. Le Génie Civil—Feb. 5, 1898. No. 18514 D.

The Electric Plant of the Paris Compressed Air Company. (Les Nouvelles Installations Electriques de la Compagnie Parisienne de l'Air Comprimé.) A fully illustrated description of the fine new power house on the Quai de Jemmapes, with details of the construction of the buildings, steam and electric plant. Two articles. Four plates. 10000 w. Le Génie Civil—Dec. 18, 25, 1897. No. 18500 G.

Shop Transmission.

Electrical Shop Transmission. H. G. Dimick. Read before the Chicago Elec. Assn. Describes a plain two-wire 220-volt system, and motors belted to line shafting in the various departments of the shop in question. 2700 w. W Electn—Jan. 29, 1898. No. 18152.

Starting.

Concerning Starting and Reversing Resistances for Shunt Motors. (Ueber Anlass- und Umkehr-Anlasswiderstände fur Nebenschlussmotoren.) E. Egger. Describing a system of magnet winding intended to increase the starting torque and diminish sparking. The method is fully shown by diagrams. 4000 w. Elektrotech Zeitschr—Feb. 3, 1898. No. 18584 B.

Transmission.

Electric Transmission Plant at Juiz de Fora, Brazil. Percy H. Thomas. Describes a rather immense plant supplied by an American manufacturing company. Ill. 2200 w. Elec Wld—Feb. 19, 1898. No. 18420.

Some Transmission Practices. Considers synchronizing two phases, changing insulators on live lines, a prony brake experiment, a novel lightning arrester, &c. Ill. 5200 w. Jour of Elec—Jan., 1898. No. 18265.

The Transmission Plant of the Apple River Power Company. A long distance plant is illustrated and described. 1800 w. Elec Wld—Feb. 5, 1898. No. 18224.

Wave Power Generator.

Morley Fletcher's Wave-Power Electric Buoy. Describes and illustrates a beacon light, and launch-charging buoy. Terminals are provided at the side of the buoy, so that an electrical launch may be moored and receive its charge of electrical energy when desired. 1600 w. Ind & Ir—Feb. 4, 1898. No. 18388 A.

TELEGRAPHY AND TELEPHONY.

Current.

The Generation of Current in the Main Telegraph Office at Stuttgart. (Die Stromerzeugungsanlage in Stuttgarter Haupttelegraphenamt.) G. Ritter & J. H. West. An elaborate account of the use of accumulator batteries at the Stuttgart telegraph office. Three articles. 7500 w. Elektrotech Zeitschr—Jan. 27, Feb. 3, 10, 1898. No. 18583 G.

Detroit.

The Detroit Telephone Company. S. P. Grace. Illustrated detailed description of the plant with brief history of the company organization. 2500 w. Elec Eng, N. Y.—Feb. 3, 1898. No. 18175.

Home Telephone.

The Home Telephone Companies. Gives the history of the Home Companies in Baltimore, Newark, Jersey City, Atlanta, Trenton, Wilmington, &c. 8800 w. Elec Engng—Feb. 15, 1898. No. 18647.

Lightning Arrester.

Welles' Safety Fuse Lightning Arrester for Telephone Apparatus. (Blitzableiter-Abschmelzsicherung der Telephon-Apparat-Fabrik Fr. Welles.) An arrangement of carbon lightning conductors and fusible wire connections, to be used in connection with the station switchboard. 1000 w. Elektrotech Zeitschr—Jan. 20, 1898. No. 18578 B.

Pacific Cable.

The Pacific Cable. From the London *Times*. Discusses the importance of this work to Canada, and the renewed interest in the subject. 1500 w. Elec Eng, Lond—Jan. 21, 1898. No. 18161 A.

Submarine Cables.

A Submarine Cable Successfully Laid Under Difficulties. Illustrated account of the laying of the Fire Island cable of the Postal Telegraph Co.'s Marine-News Service. 1400 w. Elec Rev, N. Y.—Feb. 16, 1898. No. 18411.

The Great South Bay Postal Submarine Cable Successfully Laid by the Okonite Company. An illustrated account of the carrying out of the work. The cable is laid between Fire Island and Conklin's Point, and was one of the most difficult pieces of work recently laid on this side of the globe. 1200 w. Elec Eng, N. Y.—Feb. 17, 1898. No. 18446.

Submarine Conduit.

A 557-ft. Telephone Subway under the Harlem River, New York City. Illustrated description of the interesting features in the construction and launching of this conduit. 1200 w. Eng News—Feb. 17, 1898. No. 18459.

A Submarine Conduit. Describes the method of putting in place the conduit laid across the Harlem River at New York, for carrying the cables of the American Telephone and Telegraph Co. Ill. 600 w. Elec Wld—Feb. 19, 1898. No. 18419.

Telephone Exchange.

The Delmarvia Telephone Co.'s Exchange, Wilmington, Delaware. Illustrated description. 900 w. Elec Eng, N. Y.—Feb. 17, 1898. No. 18444.

The New Exchange of The Cleveland Telephone Co. Illustrated detailed description of the equipment of the new building. 1600 w. Elec Eng, N. Y.—Feb. 17, 1898. No. 18443.

Wireless Telegraphy.

The Future of Wireless Telegraphy. Charles R. Gibson. Does not think these methods will take the place of ordinary telegraphy, but thinks if an apparatus can be made practicable for use at sea or in warfare it will greatly benefit mankind. Ill. 1600 w. Elec, Lond—Feb. 4, 1898. No. 18337 A.

Wireless Telegraphy—A Forecast. J. Rees. Predicting great changes, socially, commercially, and economically from the success of this recent discovery. 1100 w. Elec Rev, Lond—Feb. 11, 1898. No. 18486 A.

MISCELLANY.

Accumulators.

See Street and Electric Tramways.

Address.

Presidential Address of John S. Raworth before the Northern Society of Elec. Engs. of England. Deals with the problem of supplying electric power. 4000 w. Engng—Jan. 21, 1898. No 18143 A.

Alloys.

The Calculations of the Electrical Resistances of Alloys and Their Application to the Finding of Alloys of Definite Electrical Properties. C. Liebenow. Read before the Elektrotechnischen Verein on Nov. 23, 1897. Part first consists of introductory remarks and a consideration of simple alloys. 1600 w. Elec, N. Y.—Feb. 9, 1898. Serial. 1st part. No. 18324.

Alternators.

Notes on Synchronizing Alternators. H. E. M. Kensit. Gives methods for ascertaining whether the synchronizing transformers are so connected that the alternators are in phase when the lamp is bright. Ill. 1500 w. Elect'n, Lond—Feb. 4, 1898. No. 18402 A.

Armatures.

Armature Connections and Diagrams. Arthur L. Rice. Part first deals with the process of winding and connecting in various forms of armatures. Ill. 1500 w. Am Elect'n—Feb., 1898. Serial. 1st part. No. 18238.

Capacity.

Measurement of Capacity with the Balance. (Messung von Kapacitäten mit der Waage.) An adaption of Lang's method, weighing the attraction between two copper spirals, one of which is connected with the condenser. 2000 w. Elektrotech Zeitschr—Jan. 20, 1898. No. 18579 B.

Conductors.

Aluminum as a Rival of Copper for Electrical Conductors. Alfred E. Hunt. Presenting the qualities of aluminum that show its adaptability to this use, also the drawbacks. 1800 w. Elec Wld—Feb. 26, 1898. No. 18626.

Curve Tracer.

An Electric Curve Tracer. Edward B. Rosa. Discusses the value of methods of investigation by tracing the forms and phases of alternating-current curves, and the methods by which current curves have been drawn. An illustrated description of an apparatus for doing this work, which reduces the labor and increases the speed. 5200 w. Phys Rev—Jan., 1898. No. 18094 D.

Diagrams.

Conventional Electrical Diagrams. — The Chicago Electrical Association. Diagrams embodied in the report of the special committee, with statement of F. S. Hickok on the subject. 2000 w. Elec Eng, N. Y.—Feb. 24, 1898. No. 18643.

Dynamometer.

The Helmholtz Absolute Electrodynamometer. (Das Helmholtz'sche Absolute Elektrodynamometer.) Dr. K Kahle. A very full and illustrated description of the Helmholtz dynamometer, which acts by measuring the turning moment between two bobbins. 7500 w. Elektrotech Zeitschr—Feb. 3, 1898. No. 18585 B.

Electrical Action.

See Architecture and Building, Miscellany.

Electrical Advance.

Electrical Advance in the Past Ten Years. Elihu Thompson. Abstract from *The Forum*. Review of progress made in different lines. 2000 w. Min Ind & Rev—Feb. 3, 1898. No. 18304.

Electric Heating.

See Architecture and Building, Heating.

Electrical Hypothesis.

An Electrical Hypothesis for the Solar and Planetary Systems and Some of Their Associated Phenomenon. Gives an interesting hypothesis explaining the solar and planetary systems as the result of electrical energy. 2400 w. Elec Rev, Lond—Jan. 21, 1898. No. 18109 A.

Electrical Works.

The Siemens & Halske Works, at Charlottenburg, Germany. Robert Grimshaw. Illustrated description of some of the machines used in these works. 1800 w. Mach, N. Y.—Feb., 1898. No. 18299.

Films.

On the Electrical Resistance of Thin Films. Isabelle Stone. Investigations suggested by the discrepancy between the resistance of a film of given thickness measured directly by the Wheatstone bridge, as compared with the resistance calculated from its weight, density and dimensions. The metal studied is silver. 3500 w. Phys Rev—Jan., 1898. No. 18093 D.

Franklin.

Benjamin Franklin and His Electrical Experiments. Edward N. Saunders, Jr. Popular account of the early work of Franklin, and description of some of his experiments. 3000 w. Yale Sci M—Jan., 1898. No. 18312 C.

Furnace.

Contribution to the Study of the Electric Furnace. (Contribution à l'Étude des Fours Electriques.) A Memoir by MM Gin and Leleux to the French Academy, discussing the relations between temperature and current, as well as notes upon the behavior of materials fused in the electric furnace. 1800 w. Comptes Rendus—Jan. 17, 1898. No. 18521 D.

Fuses.

The Enclosed Fuse. D. J. Cartwright. A statement of the main features of various protective devices as they appear to the writer after careful study. Describes a new enclosed safety fuse designed by the writer. 1800 w. Am Elect'n—Feb., 1898. No. 18239.

Galvanometer.

A Sensitive Mirror Galvanometer. James F. Hobart. Illustrated description of an instrument intended to obviate, almost entirely, the necessity for skilled manipulation, yet will give results closely approaching those received from a more costly instrument. 1300 w. Am Elect'n—Feb., 1898. No. 18241.

India-Rubber.

The India-rubber and Gutta-percha Industries as Applied to Electrical Engineering. J. Wright. An account of how India-rubber is obtained and its preparation for commercial uses, dealing only with such processes as are involved in its preparation for electrical purposes. Ill. 3600 w. Ind & East Eng—Jan., 1898. No. 18410 D.

Low Resistance.

A Method for the Accurate Measurement of Low Resistance. Wilbur M. Stine. The method described is a modification of the Cary-Foster method. The essential idea is the employment of the standard of low resistance as the bridge wire. 1300 w. Elec Wld—Feb. 26, 1898. No. 18627.

Magnetic Fields.

Apparatus for Measuring Magnetic Fields. (Apparat zur Messung Magnetischer Felder.) Dr. Bruger. A flat spiral of bismuth is used, the change of resistance becomes a measure of the magnetic strength. 800 w. Elektrotech Zeitschr—Jan. 20, 1898. No. 18580 B.

New Method of Measuring the Intensity of Magnetic Fields. (Nouvelle Méthode pour la Mesure de l'Intensité des Champs Magnétiques.) M. E. Bouty. A liquid conductor is used in connection with the Lippman capillary electrometer. 1200 w. Comptes Rendus—Jan. 17, 1898. No. 18522 D.

On the Magnetic Field Due to a Current in a Wire Placed Parallel to the Axis of a Cylinder of Iron. G. F. C. Searle. An account of investigations made considering first the case of a cylinder of infinite radius. 2800 w. Elect'n, Lond—Jan. 28, 1898. Serial. 1st part. No. 18295 A.

Magnetism.

The Magnetic Properties of Tempered Steel. (Propriétés Magnetiques des Aciers Trempés.) Mme. Sklodowska Curie. A very valuable paper upon the influence of tempering and of composition upon the capacity of steel for permanent magnets. 25000 w. Bulletin de la Société d'Encour—Jan., 1898. No. 18532 G.

Magneto-Optics.

On the Theory of Magneto-Optic Phenomena. C. H. Wind. An examination of the theories advanced; the relation existing between the present theory and some of the older ones; and other features of the subject. 1900 w. Phys Rev—Jan., 1898. Serial. 1st part. No. 18095 D.

Metallic Conductors.

On the Electrical Conductivity of Metallic Conductors. Edouard Branly. From the *Comptes Rendus*. An account of recent experiments. 900 w. Elec Eng, N. Y.—Feb. 17, 1898. No. 18445.

Report.

Report of the Work of the Physical-Technical Reichsanstalt. (Thätigkeits Bericht der Physikalisch-Technischen Reichsanstalt.) A general résumé of the work of the Imperial testing bureau, giving many details of work done, especially in examining and comparing standards. Two articles. 6000 w. Elektrotech Zeitschr—Feb. 3, 10, 1898. No. 18586 E.

Rheostats.

Liquid Rheostats. H. S. Webb. Tests made to obtain data from which the dimensions of a liquid rheostat for the dissipation as heat of a given amount of energy could be calculated, when the maximum current and E. M. F. are known. 1200 w. Am Elect'n—Feb., 1898. No. 18237.

Sparking.

Sparking in Dynamos. Eustace Thomas. Briefly explains the causes of sparking, and shows the inadequacy of the commonly-accepted theories. Discusses the mathematical equations, and the practical conditions which give a minimum of sparking. The advantages of multipolar construction are especially emphasized. 2000 w. Elect'n, Lond—Feb. 18, 1898. No. 18737 A.

Storage Battery.

See Street and Electric Tramways.

Transformers.

Practical Methods of Transformer Testing. J. H. Barbour and K. G. Glover. Abstract of a thesis test. Gives methods used. Ill. 900 w. Sib Jour of Engng—Feb., 1898. No. 18611 C.

Wire.

Concerning Weatherproof Wire. Alex. Dow. Defending the use of this covering and showing that it has a value. 2000 w. Elec Engng—Feb. 1, 1898. No. 18092.

X-Rays.

The Source of the X-Rays. John Trowbridge and John E. Burbank. Describes experiments made with various tubes and states results. Ill. 2000 w. Am Jour of Sci—Feb., 1898. No. 18129 D.

MARINE ENGINEERING.

American Shipping.

Arthur Sewall's Views on American Shipping. An article from the *N. Y. Tribune*, giving an interesting interview. 3700 w. Sea—Feb. 17, 1898. No. 18453.

Cruiser.

H. M. S. Argonaut. Description, with illustration, of a protected cruiser of the Diadem type, launched Jan. 24, 1898, from the yard of the Fairfield Shipbuilding Co. 2000 w. Engr, Lond—Feb. 4, 1898. No. 18377 A.

Dock.

The Floating Dock for the Harbor of Loanda. (Schwimmdock für den Hafen von Loanda.) With photograph of the dock afloat as well as longitudinal and cross sections. 1000 w. Zeitschr d Ver Deutscher Ing—Jan. 15, 1898. No. 18548 D.

Dry Docks.

See Civil Engineering, Harbors.

Ferry Boats.

Danish Ferry Boats. (Die in Dänemark in Verwendung stehenden Ueberfuhrsboote.) An account of the ferry systems in use among the islands of Denmark, both for general traffic and for transportation of railway cars. 1 plate. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1898. No. 18560 D.

Framing.

Some Considerations in Connection with the Transverse Framing of Ships. H. E. J. Camps. Read before the N. E. Coast Inst. of Engs. and Shipbuilders, at West Hartlepool. The type of vessel chosen for discussion is a three-deck ship, and the writer considers what she would have been if built on each of the several systems of framing. Ill. 2300 w. Ind & Ir—Jan. 21, 1898. Serial. 1st part. No. 18145 A.

H. M. S. "Diadem."

Trials of H. M. S. "Diadem." Editorial on the trials now taking place in the English Channel, giving some of the features of the ship and her machinery. 1800 w. Engng—Jan. 21, 1898. No. 18135 A.

Iron Ships.

The Earliest Iron-Built Ships. Historical review of the earliest efforts at iron-ship construction in Great Britain. 2200 w. Engr, Lond—Jan. 21, 1898. No. 18116 A.

Japan.

See Economics and Industry, Commerce.

Paddle Steamer.

Hungarian Paddle Steamer I. Ferencz Jozef. Working drawings and description of the engines of this steamer, which has been previously indexed. 700 w. Eng, Lond—Feb. 4, 1898. No. 18374 A.

Propellers.

Defects in Propeller Shafts. M. W. Aisbitt. Abstract of paper read at meeting of Inst. of Marine Engineers, Cardiff. Presents certain defects and discusses means of remedying them. Also discussion. 6000 w. Steamship—Feb., 1898. No. 18338 A.

Revenue-Cutter Service.

The United States Revenue-Cutter Service. H. D. Smith. Historical account of the service, its hardship and danger, giving interesting incidents. Ill. 4800 w. Century Mag—Feb., 1898. No. 18125 D.

Russian Yacht.

The Russian Imperial Yacht "Standart." Elevations and plans of the ship, with interior views and description. 2500 w. Engng—Jan. 28, 1898. No. 18269 A.

Shipbuilding.

Shipbuilding as a Productive Industry in Great Britain. James McKechnie. In this paper Mr. McKechnie discusses the economic features of the situation, and shows that in the rising competition the ratio of output to wages is the deciding factor. 3500 w. Engineering Magazine—March, 1898. No. 18593 B.

Ship Yard.

Most Modern of Lake Ship-Yards. Illustrates and describes some of the details of the plant at Lorain, Ohio. 1100 w. Ir Trd Rev—Feb. 24, 1898. No. 18680.

Signal Apparatus.

Rotary Field Signal Command Apparatus. (Drehfeld-Fernzeiger als Signal- und Kommando Apparate.) Describing an improved form of dial signal apparatus for communication of orders from the bridge to the engine room of a vessel. The indications are transmitted by the rotation of a magnetic field. 4500 w. Glaser's Annalen—Feb. 1, 1898. No. 18567 D.

Steam Yacht.

Description of the New Steam Yacht for Colonel Oliver H. Payne. General design, dimensions and description of a fine yacht to be built by the Bath Iron Works, of Bath, Me. 2200 w. Marine Engng—Feb., 1898. No. 18298 C.

Submarine Boat.

Construction and Operation of the Submarine Boat Argonaut. Photographs and scale drawing with description of construction and operation. 2200 w. Marine Engng—Feb., 1898. No. 18297 C.

Travelling Gantry.

See Mechanical Engineering, Shop & Foundry.

Water Ballast.

Water Ballast in Steamers. Side Tanks. Archibald M'Glashan. Read at meeting of North-East Coast Institution of Engineers and Shipbuilders, at West Hartlepool. An inquiry into the question of how far recent developments in shipbuilding and in the working of steamers affect this subject. Discussion. 2500 w. Steamship—Feb., 1898. No. 18339 A.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Tests.

Tests of Water-Tube Boilers With Horizontal and Vertical Passes. George H. Barrus. Describes tests made on two 200 h. p. horizontal water-tube boilers set side by side in one battery of brick work. 900 w. Eng Rec—Feb 19, 1898. No. 18637.

Circulation.

The Circulation of Water in Steam Boilers. (La Circulation de l'Eau dans les Chaudières.) Ch. Bellens. Discussing and in some respects opposing the recent theories of M. Brillié upon the same subject. Serial. 1st part. 3500 w. La Revue Technique—Jan. 25, 1898. No. 18527 D.

Draft.

Improved System of Mechanical Draft for Furnaces. (Nouveau Procédé de Tirage Mécanique des Foyers.) The Prat system uses a blast of air from a fan blower to induce a current in a larger vertical aspirator connected to the boiler flue. Excellent results are obtained at small cost. 3000 w. Le Génie Civil—Jan. 29, 1898. No. 18511 D.

Furnaces.

Increasing the Draught of Furnaces. From *Uhlands Technische Rundschau.* Reviews the methods for increasing the draught of a chimney shaft, and briefly discusses which is preferable. 1500 w. Col Guard—Feb. 4, 1898. No. 18382 A.

Heaters.

Feed-Water Heaters and Economizers. William H. Fowler. Deals with feed water heaters and fuel economizers. Ill. 2800 w. Ry Wld—Feb., 1898. No. 18393 A.

Incrustation.

Removal of Boiler Incrustations. (Désincrustation des Chaudières.) M. Schmidt. Describing the success obtained in loosening boiler scale by rapid cooling and washing out when cold. 6000 w. Bulletin de la Société d'Encour—Jan., 1898. No. 18534 G.

Superheating.

The Application of Superheated Steam. (Die Anwendung Ueberhitzten Dampfes.) M. F. Gutermuth. A theoretical discussion, accompanied by extensive tables of tests as well as illustrations of the Schmidt boiler and superheater. 6000 w. Zeitschr d Ver Deutscher Ing—Feb. 5, 1898. No. 18551 D.

The Schwoerer Steam Superheater. (Der Dampfüberhitzer von Schwörer.) A general discüssion of superheating with data of tests showing an economy of about 20 per cent. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 29, 1898. No. 18550 D.

Tests.

Boiler Testing with Various Fuels. David P. Jones. Abstract of paper read before the Am. Soc. of Naval Engs., at Washington, D. C. Discusses methods of testing with coal, oil, waste gases of blast furnaces, and bagasse. 3800 w. Eng News—Feb. 3, 1898. No. 18203.

Volatile Oils.

Physical and Chemical Properties of Volatile Oils in Boilers. W. H. Edgar. Address before the Northwestern Elec. Assn. at Milwaukee. Discusses the use of oils to counteract the evil effect of incrustation, especially of kerosene and petroleum and their different distillates. Discussion. 4400 w. W Electn—Jan. 29, 1898. No. 18151.

COMPRESSED AIR.

Compressors.

New Types of Ingersoll-Sergeant Air Compressors. Describes two recent designs. Ill. 800 w. R R Gaz—Feb. 11, 1898. No. 18328.

Explosions.

Compressed-Air Explosions—A Recent Typical Explosion. Frank Richards. Considers the dangers from imperfect design and mismanagement. 1500 w. Am Mach—Feb. 3, 1898. No. 18248.

Explosions in Air Compressors and Receivers. T. G. Lees. Abstract of paper read at meeting in Sheffield, Eng. Describes explosions which occurred at Clifton Colliery, the conditions which caused them and gives lessons to be learned. 2400 w. Ir & Coal Trds Rev—Feb. 11, 1898. No. 18605 A.

Formulas.

Useful Compressed-Air Formulas. W. L. Saunders. Gives rules and formulas used by the writer in the application of compressed air. 1000 w. Compressed Air—Feb., 1898. No. 18638.

ENGINES AND MOTORS.

Accumulators.

The Manufacture of Tudor Accumulators. Illustrated detailed description. 1800 w. Elec Rev, Lond—Jan. 28, 1898. No. 18291 A.

Diesel Motor.

Recent Developments in Diesel Motors. Information from report of Alfred Musil published in the *Journal für Gasbeleuchtung*, with short biographical sketch and portrait of Rudolph Diesel. 1300 w. Pro Age—Feb. 15, 1898. No. 18412.

The Diesel Oil-Motor. Interesting particulars from articles by Bryan Donkin and M. Hospitalier. Ill. 3000 w. Automotor Jour—Feb., 1898. No. 18677 A.

The Diesel Rational Heat Motor. States the conditions regarded as essential for an economic heat engine, defines ignition and combustion, and gives comparison of efficiency, &c. Ill. 2800 w. Elec Eng, N. Y.—Feb. 17, 1898. No. 18447.

Engine Development.

Long-Stroke Cylinders and Piston Valves

George W. Cushing. Facts showing advances made and what has influenced the progress. Ill. 2500 w. Ry Mas Mech—Feb., 1898. No. 18257.

Exhaust.

The Economical Utilisation of Exhaust Steam. Bryan Donkin. Reviews the various methods of utilising the energy in exhaust steam, comparing the relative economy of jet and surface condensation as well as the use of exhaust for feed water heating. 2500 w. Engineering Magazine—March, 1898. No. 18-592 B.

Generating Unit.

See Electrical Engineering, Lighting.

Horizontal Engine.

Horizontal Engine at the Brussels Exhibition. Illustrated description of engine constructed by the firm of M. J. Preudhomme-Prion, of Huy, Belgium, which was received with favor. 600 w. Engng—Feb. 11, 1898. No. 18479 A.

Injectors.

Locomotive Injectors. J. A. Bischoff. Read at the Locomotive Foreman's Club, Chicago. Treats of the essential active parts of an injector, the action, and causes which prevent working, with suggestions. 3000 w. Ry Mas Mech—Feb., 1898. No. 18258.

Intercepting Valves.

Some Engineering Designs, as Shown in Intercepting Valves for Locomotives. Illustrates and describes several designs 1200 w. Am Mach—Feb. 24, 1898. No. 18686.

Pumping Engine.

Pumping Engines. R. J. Worth. Read at Cleveland Inst. of Engineers, at Stockton-on-Tees. Abstract giving points on engines in general, and briefly considering special types. Short discussion. 2000 w. Col Guard—Jan. 21, 1898. No. 18141 A.

See Municipal Engineering, Sewerage.

See Municipal Engineering, Water Supply.

Slide Valves.

Setting Slide Valves. Thomas Hawley. Abstract of a lecture delivered before the Wells Memorial Inst., Boston. Gives some points and suggestions regarding the methods. 1800 w. Bos Jour of Com—Feb. 12, 1898. No. 18353.

Steam Gages.

Some Notes on Locomotive Steam Gages. Theo. H. Curtis. How steam gages may be in error even when shown to be correct by the test-gage. 1000 w. Ry Mas Mech—Feb., 1898. No. 18259.

Steam Plant.

Test of Steam Plant of the Hood Rubber Co., East-Watertown, Mass. George H. Barrus. Illustrates complete test of engines and boilers. 3000 w. Eng Rec—Feb. 5, 1895. No. 18218.

POWER AND TRANSMISSION.

Canada.

Water Power in Canada Presidential address at the annual meeting of the Canadian Society of Civil Engineers. Calls attention to this widely distributed power, its use for transmission purposes, electrical demand, the ice question, &c. 4500 w. Can Engr—Feb., 1898. No. 18323.

Compression.

The Compression of Steam in the Clearance Space. (Sur la Compression de la Vapeur dans l'Espace Mort.) H. Hubert. A discussion of Prof. Déry's investigations into the losses due to condensation during compression. 3500 w. Revue Universelle des Mines—Jan., 1898. No. 18536 H.

Elevators.

Elevators and Their Inspection. H. V. Loss. Read before the International Convention of Building Commissioners and Inspectors at Detroit. A criticism of the methods employed by the elevator casualty insurance companies, and suggestions considered important for the safety of elevators. 2500 w. Arch & Build—Feb. 19, 1898. Serial. 1st part. No. 18618.

Hydraulic or Electric Elevators. Two communications from P. R. Moses and Horatio A. Foster on the relative economy of hydraulic and electric apparatus. 2000 w. Eng Rec—Feb. 5, 1898. No. 18216.

Modern Elevators. Fred C. Floyd. Read before the International Convention of Building Commissioners and Inspectors, at Detroit. Considers the causes that have made the elevator a necessity, and the efficiency that has made possible the erection of high buildings; also the dangers, and safety devices. 3200 w. Arch & Build—Jan. 29, 1898. No. 18096.

Exposition.

Steam Engines at the Brussels Exposition, 1897. (Exposition de Bruxelles 1897. Les Moteurs à Vapeur.) Emile Masson. A general account of the steam engines exhibited, including among others, the Schmidt Superheated steam engine. 6000 w. 1 plate. Revue Universelle des Mines—Jan., 1898. No. 18537 H.

Power Presses.

Early Power Presses. Work of a Vermont man in this line with some information from N. C. Stiles. Ill. 800 w. Mach, N. Y.—Feb., 1898. No. 18301.

Power Sources.

Steam, Gas and Electricity as Sources of Energy in Chemical Works. F. H. Bowman. Read before the Manchester Section of the Society of Chemical Industry, England. Discusses the advantages and disadvantages of each of the sources named. 2200 w. Jour Gas Lgt—Jan 25, 1898. No. 17705 A

Water-Wheel Regulation.

Regulation of Water-Wheels under High Pressure. Describes method of regulation of Pioneer Electric Power Co.'s wheels. 800 w. Eng Rec—Feb. 5, 1898. No. 18215.

Speed Government in Water-Power Plants. Mark A. Replogle. Discussion of some of the principles that must be adhered to if successful regulation is to be obtained. Ill. 6400 w. Jour Fr Inst—Feb., 1898. No. 18263 D.

Water-Wheels.

Horse Power of Water-Wheels and Turbines. Olin H. Landreth. Gives a diagram for the graphical determination of the horse power of any given water fall, explaining how to use it. 400 w. Am Elect'n—Feb., 1898. No. 18240.

Wave Power Generator.

See Electrical Engineering, Power.

Worm Gearing.

See Street and Electric Tramways.

SHOP AND FOUNDRY.

Blower.

The Uses of the Blower in the Foundry. Walter B. Snow. Read before the New England Foundry Men's Assn. Gives the theoretical considerations which govern the design of fan blowers and their operation, the different types employed in the foundry and some of the uses. 4000 w. Ir Age—Feb. 10, 1898. No. 18317.

Brass.

The Influence of Antimony on the Cold Shortnesss of Brass. Erwin S. Sperry. An account of experiments made by varying the amount of antimony of a constant composition. Ill. 4500 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18470 D.

Brass Furnaces.

Improved Brass Furnaces. D. C. Thompson. Gives a description, with illustrations, of twin furnaces of the cylinder type. 1500 w. Foundry—Feb., 1898. No. 18260.

Centrifugal Force.

Diagram for Finding Centrifugal Force and Rim Tension. N. J. Hopkins. Explanation for the use of curves which will reduce the labor of calculating. 250 w. Am Mach—Feb. 17, 1898. No. 18437.

Coupling.

The de Bovet Magnetic Coupling. (Magnetische Kupplungen, System de Bovet.) The device consists of a cone coupling drawn into engagement by a powerful annular electro-magnet. Various modified arrangements are shown. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—Feb 11, 1898. No. 18545 B.

Cupolas.

Cupola Linings. Linson H, De Voe. Read at meeting of the Foundrymen's Assn., Philadelphia. Briefly outlines several methods. 2200 w. Ir Age—Feb. 10, 1898. No. 18314.

Die.

Die for Punching Holes in Armature Blanks. William Baxter, Jr. Illustrated description. 1200 w. Am Mach—Feb. 10, 1898. No. 18332.

Drawings.

Black-Print Processes. Albert E. Guy. Mentions the defects of the blue-print process, and presents the difficulties attending the manufacture of black-print paper. 2500 w. Am Mach—Feb. 17, 1898. Serial. 1st part. No. 18432.

Drill.

The Davis Calyx Drill. An illustrated description of a drill, the special features being the cutter, which is of hardened steel; and the calyx, an apparatus for catching the particles of rock. 1600 w. Ir & Coal Trds Rev—Jan. 28, 1898. No. 18278 A.

Drying.

Modern Drying Apparatus. (Moderne Trockenanlagen.) A discussion of the action of heat in increasing the absorbing capacity of air for moisture, together with the theory of air-drying apparatus. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 22, 1898. No. 18549 D.

European Foundries.

Some Observations of an American Iron Man Abroad. Archer Brown. General account of points noticed which differ from American ways. 1300 w. Foundry—Feb., 1898. No. 18261.

Exhibition.

The Exhibition of Foundry Supplies at Goslar. (Giesserei-Fachausstellung in Goslar.) Describes many improved forms of molding machines, blowers and other foundry apparatus, as exhibited at Goslar, Hanover, in September, 1897. Three articles, 10000 w. 1 plate. Stahl und Eisen—Jan. 15, Feb. 1, 15, 1898. No. 18568 H.

Flat Heads.

Investigation of Distortion and Resistance of Flat Heads. C. Bach. Translated and abridged by Gus C. Henning, from the *Zeitschrift des Vereines Deutscher Ingenieure*. Investigations in this field, covering flanged heads of wrought and cast materials, giving tests. Ill. 1500 w. Am Mach—Feb. 17, 1898. No. 18436.

Gun Factory.

The Gun Factory at the United States, Washington, D. C., Navy Yard. Illustrated description of the work as carried on at this shop. 1500 w. Sci Am—Feb. 26, 1898. No. 18644.

Hammers.

Steam Hammers—Past and Present. Illustrated description of old forms and new, showing the great progress made in this century. 2000 w. Ir & Coal Trds Rev—Feb. 11, 1898. No. 18604 A.

Iron Alloys.

Chemistry in Foundry Practice. S. S. Knight. An introduction to a series of articles relating to this subject. Part first deals with two alloys of iron, giving experiments of the writer. 2200 w. Foundry—Jan., 1898. No. 18187.

Jacquard Machine.

The Verdol Jacquard Machine. (Piquage Mécanique Verdol.) A report upon the improved apparatus of M. Verdol in which perforated paper is substituted for the original form of Jacquard cards. The machine for piercing the cards is fully described and illustrated. 7500 w. Bulletin de la Société d'Encour—Jan., 1898. No. 18530 G.

Lathes.

An 8"x20" Bench Lathe for the Amateur Electrician. Herbert I. Washburn. Illustrated description of a proposed design. 600 w. Am Mach—Feb. 10, 1898. No. 18331.

Lock Nuts.

The Helicoid Lock Nut. Illustrated description of a locking nut possessing the virtues of locking, and that it can be screwed on and off its bolt with facility. The manufacturing works are illustrated and the operations given in detail. 2200 w. Engng—Feb. 4, 1898. No. 18370 A.

Lubricator.

A Continuous Automatic Lubricator. (Graisseur Automoteur Continue.) A Report upon the improved lubricator designed by M. Barré. A continuous circulation of oil is maintained by an automatic pumping device. 3500 w. Bulletin de la Société d'Encour—Jan., 1898. No. 18531 G.

Melting.

Economy in Melting. J. P. Pero. Considers in detail the factors involved in melting iron economically. 2400 w. Foundry—Jan., 1898. No. 18188.

The Melting Ratio. W. F. Prince. Discusses the progress and improvements in the melting and cupola practice. 1500 w. Foundry —Jan., 1898. No. 18189.

Metal Stamping.

Development of Machinery for Sheet Metal Stamping. Oberlin Smith. A review of the increasing use of stamped metal work for many purposes in which more expensive methods were formerly used; with many examples of products of the stamping and drawing press. 3500 w. Engineering Magazine—March, 1898. No. 18596 B.

Mixtures.

Changes in Foundry Mixtures. Eugene W. Smith. Read before the Western Foundrymen's Assn. Presents some of the mechanical changes due to handling, showing the absolute care that must be taken to obtain uniform results. 1200 w. Ir Age—Feb. 24, 1898. No. 18639.

Molding.

The Avery Molding Machine. Illustrated description of an apparatus and plan of molding in strange contrast to the usual custom, but which has more than satisfied the expectations. 1500 w. Foundry—Jan., 1898. No. 18184.

The Molder's Hot Spot. R. D. Moore. Examples given illustrate points requiring skill and give suggestions. Ill. 1000 w. Foundry —Jan., 1898. No. 18186.

Nickel Steel.

Nickel Steel for Crank Pins and Axles. H. F. J. Porter. A paper containing much information concerning steel, with results of tests, mechanical treatment, improvement of quality, &c. 3300 w. R R Gaz—Feb. 25, 1898. No. 18664.

Oxidation.

Oxidation of Foundry Metals. Thomas D. West. Read before the Pittsburg Foundrymen's Assn., Jan. 31, 1898. Reports a series of original tests, and concludes that if it were possible to secure clean iron, free of all sand, rust or film of oxid, the loss of metallic iron due to oxidation would not be as large as has been generally supposed. 2500 w. Ir Trd Rev—Feb. 3, 1898. No. 18185.

Phosphorus.

Effects of Phosphorus on the Strength and Fusibility of Iron. Thomas D. West. Read at meeting of the Pittsburg Foundrymen's Assn. Gives experiments and results. 900 w. Am Mfr & Ir Wld—Feb. 4, 1898. No. 18250.

Planing.

Time Saving in Planing. Henry Hess. Gives methods and shows the importance of the highest possible cut-rate and the small value of further increase of speed on the return stroke. 1000 w. Am Mach—Feb. 24, 1898. No. 18685.

Riveting.

Experiments on the Resistance of Riveted Plates to Slipping. (Expériences sur la Résistance des Tôles Rivées au Glissement.) A full account of the experiments made in Holland by Schroeder van der Kolk with details of the apparatus and diagrams from the autographic records of the testing machine. Three articles. 7500 w. Le Génie Civil—Dec. 25, 1897, Jan. 1, 8, 1898. No. 18502 H.

Roller Bearings.

Modern American Roller Bearings and their Reduction of Friction. (Ueber die Neuen Ameri-Kanischen Rollenlager und die damit Erzielte Ersparniss au Reibung.) Prof. F. Reuleaux. Paper before the German Railway Society, with many illustrations of ball and roller bearings and their mechanical applications. 7500 w. Glaser's Annalen—Feb. 1, 1898. No. 18566 D.

Screw Cutting.

Accurate Screw Machine Work-Screw Cutting. J. O. Surface. Explanation of some methods and tools by which difficulties in this work may be overcome. Ill. 1500 w. Am Mach—Feb. 3, 1898. No. 18249.

Screw Threads.

Instruments for Gauging Screw Threads. (Sur les Instruments Vérificateurs des Filetages.) M. Marré. Describing a system of gauges intended for use on the metric screw thread system known as the *Système Français*, (S. F.) with table for the system. 6000 w. Bulletin de la Société d'Encour—Jan., 1898. No. 18533 G.

Test Bars.

Test Bars and Their Relation to the Strength of Castings. Herbert E. Field. Considers that the test bars fail to accomplish the purpose for which they are used. 2800 w. Mach, N. Y.—Feb., 1898. No. 18300.

Tools.

Tool Books. L. D. Burlingame. Suggestions for keeping a systematic record of all tools for special work. 1800 w. Am Mach—Feb. 17, 1898. No. 18433.

Travelling Gantry.

Travelling Gantry at Messrs. Harland and Wolff's Shipyard, Belfast. Describes machines used for lifting of plates and sections into po-

sition, and to support riveting machines when at work. 1100 w. Engng—Jan. 28, 1898. No. 18266 A.

Wire Mill.

A Copper Wire Mill. R. An interesting account of a visit to the Waclark Manufacturing Company at Bay View, N. J., describing the operations. 1900 w. Am Mach—Feb. 17, 1898. No. 18434.

MISCELLANY.

Aeronautics.

Aeronautics in 1897. (Die Aëronautik im Jahre 1897.) A general review of progress in the past year, with especial reference to the mechanical features involved. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 11, 1898. No. 18544 B.

Agricultural Machinery.

Agricultural Machinery and Tools Exhibited at Stuttgart and Hamburg. (Die Landwirthschaftlichen Maschinen und Geräte in Stuttgart und in Hamburg.) Giving illustrations of many of the modern plows, cultivators and similar machines shown at these recent exhibitions. Serial. 1st part. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 15, 1898. No. 18546 D.

Analytical Work.

The Dignity of Analytical Work. C. B. Dudley. Presidential address delivered at the Washington meeting of the American Chemical Society. A discussion of analytical work, its value and importance, giving illustrations and examining the differences in the work of pure and applied chemists. 6300 w. Science—Feb. 11, 1898. No. 18335.

Automobiles.

Motor Wagons for Municipal Work. F. J. Warden-Stevens. A discussion of the suitability of these vehicles for this work, the kind of power to be adopted, &c. 2000 w. Arch. Lond—Feb. 11, 1898. No. 18498 A

Some Difficulties of Motor-Vehicle Construction. Deals with the difficulties to be found in the application of oil to the moving of road-vehicles. 2000 w. Automotor Jour—Feb., 1898. No. 18678 A.

Some Points in the Design of Automobile Vehicles Intended for Heavy Traffic. George Herbert Little. Abstract of a paper read before the Self-Propelled Traffic Assn., of Liverpool. Part first considers the means of effecting cheap internal transport by means of automobile vehicles, existing practice in handling heavy loads, the features of the most recent examples of automobile vehicles, &c. 4400 w. Ind & Ir—Jan. 28, 1898. Serial. 1st part. No. 18281 A.

Bicycles.

Chainless Bicycles. Howard Lee Davis. Describes the difficulties overcome, the construction, and tests made. Ill. 2000 w. Yale Sci M—Jan., 1898. No. 18313 C.

Breech Mechanism.

Schneider-Canet Quick-Firing Breech Mechanism. Illustrated description of the 15 cm. (5.9 in.) breech gear. 1200 w. Engr, Lond—Feb. 11, 1898. No. 18482 A.

Deformation.

The Law of the Deformation of the Industrial Metals. (Loi des Déformations des Metaux Industriels.) Marcel Brillouin. A mathematical discussion of deformations, based on the crystalline structure of the material, and including the time element, and the influence of shocks. 1200 w. Comptes Rendus—Jan. 24, 1898. No. 18523 D.

Elasticity.

Report on the Investigations of MM. Gossot and Lionville. (Rapport sur les Travaux de MM. Gossot et Lionville.) An abstract of investigations into the elastic action of steel hoops when used as reinforcements for tubes, as in the case of artillery. Prize paper of the French Academy. 2000 w. Comptes Rendus—Jan. 10, 1898. No. 18517 D.

Frictional Losses.

Frictional Losses in a Hydraulic Intensifier. Walter Ferris. Gives experiments made at the Pencoyd Iron Works, with the idea of obtaining information as to the frictional losses in hydraulic machinery and to see to what extent the formulas given by engineering authorities correspond with practice. 1400 w. Am Mach—Feb. 3, 1898. No. 18247.

Hydraulic Jointing.

Hydraulic Jointing of Tubular Structures. Illustrated description of process invented by Charles T. Crowden. 2500 w. Ind & Ir—Feb. 4, 1898. No. 18387 A.

Maxim Gun.

The Maxim Gun. It is proposed to give a somewhat full description of the gun as it now exists. Part first considers the origin of the gun and some of the steps by which it has been brought to its present development. Ill. 2500 w. Engng—Feb. 11, 1898. Serial. 1st part. No. 18477 A.

Refrigerating Machines.

Medium and Small Independent Refrigerating Plants. Illustrated description of the methods of refrigerating adopted by the Atlantic Refrigerating Co., of Springfield, Mass. 1200 w. Sci Am—Feb. 12, 1898. No. 18308.

Rubber.

Singular Stress-Strain Relations of India-Rubber. R. H. Thurston. From *Science*. Calling attention to the rapid increase in resistance just before rupture. 900 w. Sib Jour of Engng—Feb., 1898. No. 18612 C.

Submerged Pipe.

A Submerged Steel Pipe with Flexible Joints at Portland, Ore. Points of interest in this work and part of the specifications relating to the flexible and flanged joints. Ill. 1400 w. Eng News—Feb. 10, 1898. No. 18322.

Testing.

On the Permanent Deformation and Rupture of Metals. (Sur les Deformations Permanentes et la Rupture des Metaux.) M. G. A. Faurie. An examination of the phenomena of nodality in metals under tension tests. 1000 w. Comptes Rendus—Jan. 31, 1898. No. 18524 D.

MINING AND METALLURGY.

COAL AND COKE.

Bituminous Collieries.

Surface Plants of Bituminous Collieries. W. G. Wilkins. Read at meeting of Ohio Inst. of Min. Engs. Calls attention to some of the principles and appliances that should be considered in the design, laying out, and construction of the surface plants of bituminous collieries, in order to save labor and expense, and therefore reduce the surface cost of the mine output. 4400 w. Am Mfr & Ir Wld—Jan. 28, 1898. No. 18103.

Coal Deposits.

Structure of the Coal Deposits of the Trans-Mississippian Field. Charles R. Keyes. Calls attention to features brought out by recent information of this region, and facts that have an important bearing upon mining. 2500 w. Eng & Min Jour—Feb. 26, 1898. Serial. 1st part. No. 18684.

Coal Dust.

Precautions Against the Dangers of Coal Dust. From M. Haton de la Goupillière's *Course of Mine Working*. Gives methods in use as a preventive against danger. 2000 w. Col Guard—Feb. 11, 1898. No. 18603 A.

Coal Measures.

Clay Veins Vertically Intersecting Coal Measures. W. S. Gresley. Presents a record of observations on dike-like deposits of clay and other material traversing the bituminous-coal regions west of the Allegheny Mountains, together with illustrations of and references to allied phenomena in other countries. 6800 w. Bul of Geol Soc of Am—Jan. 18, 1898. No. 18407 D.

Coal Mining.

Tests of an Electric Coal-Mining Plant. Clifford Buck and Clay Belsley. Report presented as a thesis at Sibley College, Cornell Univ. An unusually fine piece of work of its class, showing the records of performance and efficiencies of electric-driven apparatus under conditions of actual work in a coal mine. 2400 w. Eng News—Feb. 24, 1898. No. 18652.

Coke.

The Sulphur Contents of Coke in their Relation to Blast Furnace and Cupola Practice. Oscar Simmersbach. Translated from *Stahl und Eisen*. States on what the sulphur contents in coke depends, why sulphur in coke is injurious in the blast furnace, and in the cupola, and suggests how lower sulphur contents may possibly be obtained. 1800 w. Am Mfr & Ir Wld—Jan. 28, 1898. No. 18101.

Culm Flushing.

The Method and Cost of Flushing Culm into Anthracite Mines. Report of the committee appointed to investigate this subject, prepared by James B. Davies, superintendent of the "Black Diamond" and "Dodsin" collieries. Gives the mode of filling these mines with culm, the expenses and suggestions for improvements. Ill. 7000 w. Anth Coal Op Assn—Feb., 1898. No. 18207.

Explosion.

The Sunshine Coal Mine Explosion. An extract from a special report made to the governor of Colorado by the inspector of mines, David Griffiths. Ill. 2000 w. Mines & Min—Feb., 1898. No. 18347 C.

Formation.

The Rock Formation at La Tombe. (Le Massif de La Tombe.) A paper by M. J. Smeysters, upon the formations and faults in the coal measures about Charleroi, Belgium. 5000 w. 4 plates. Revue Universelle des Mines—Jan., 1898. No. 18535 H.

France.

Saint-Eloy Collieries, Allier, France. From notes of a visit by members of the Société de l'Industrie Minérale attending the Montluçon Congress, communicated to the *Comptes Rendus Mensuels* of the society. Describes deposit, method of working, shafts, boilers, haulage, &c. 1500 w. Col Guard—Feb. 11, 1898. No. 18600 A.

Lancashire Coalfields.

The Nomenclature of the Lancashire Coalfields. Herbert Bolton. Abstract of paper read at special meeting of the Manchester Geological Society. Considers the terms that might have been or are still in use in referring to the seams of the lower measures. 1800 w. Col Guard—Feb. 4, 1898. No. 18383 A.

Nitrogen.

History of Nitrogen in Coal. Herman Poole. The object of the article is to recount some of the sources of the nitrogen in coal and to trace its history through its various changes. 2000 w. Am Gas Lgt Jour—Feb. 7, 1898. No. 18245.

Origin.

The Carboniferous Age and the Origin of Coal. A statement of the different theories advanced. Ill. 1500 w. Ir & Coal Trds Rev—Feb. 4, 1898. No. 18386 A.

The Origin of Coal. A. de Lapparent, in the *Revue de Questions Scientifiques*. From a lecture to the Société Scientifique, Brussels. Part first explains proper methods of investigation, and gives some theories of prominent geologists. 3000 w. Col Guard—Jan. 28, 1898. Serial. 1st part. No. 18270 A.

Safety Cage.

Moustier Safety Cage. M. Vallat. From a communication to the Société de l'Industrie Minérale, Saint-Etienne. Brief illustrated description. 700 w. Col Guard—Jan. 28, 1898. No. 18272 A.

Treatment.

The Mechanical Treatment of Coal. Horace J. Greaves. Read before the Derbyshire Metallurgical and Engineering Assn, The different methods are discussed, and the means of treating the various kinds of coal and their

value. 3800 w. Col Guard—Feb. 4, 1898. No. 18384 A.

COPPER.

Copper Deposits.

The Origin and Mode of Occurrence of the Lake Superior Copper-Deposits. M. E. Wadsworth. A description of the geology of this region, with discussion of the ore deposits, their origin, &c. 12400 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18474 D.

Copper Mattes.

A Study of the Elimination of Impurities from Copper Mattes in the Reverberatory and the Converter. Edward Keller. A comparison of the two methods, working on the same material on an extensive scale. 7200 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18469 D.

Refining.

Purification of the Electrolyte in Copper Refining. A translation of the essential portions of a paper by Titus Ulke, which appeared in the *Zeitschrift für Elecktrochemie*, with critical comments. 1600 w. Elect'n, Lond—Feb. 11, 1898. No. 18497 A.

Smelting.

The Garretson Copper Smelting Furnace. Illustrated description, with letter from E. D. Peters, Jr., explaining the theories and methods involved in the construction and operation. 1700 w. Eng & Min Jour—Feb. 5, 1898. No. 18219.

Wire Mill.

See Mechanical Engineering, Shop & Foundry.

GOLD AND SILVER.

Amalgamation.

Temperature in Amalgamation. Editorial calling attention to the fact, ascertained by experiment, that the cooling of the water used in the stamp-mill batteries very considerably increases the yield of gold. A few quotations from writers as to the cause of this difference are given. 1400 w. Eng & Min Jour—Jan. 29, 1898. No. 18105.

Assaying.

The Assaying of Gold Bullion. C. Whitehead and T. Ulke. Gives the method used by the United States mints and assay offices in assaying "unparted bars." 1600 w. Eng & Min Jour—Feb. 12, 1898. No. 18367.

The Assaying of Silver Bullion. C. Whitehead and T. Ulke. An explanation of methods used. 3300 w. Eng & Min Jour—Feb. 26, 1898. No. 18683.

Bromine Process.

The Bromine Extraction Process. Particulars of the process, furnished by Horace F. Brown. 1800 w. N Z Mines Rec—Jan. 17, 1898. No. 18416 B.

Comstock Lode.

The Deep Levels of the Comstock Lode. Urging the pumping out and resuming the work at depth. 2000 w. Min & Sci Pr—Feb. 5, 1898. No. 18309.

Coolgardie.

The Coolgardie Gold Fields Water Supply. Explains the scheme for supplying this great gold centre with an abundance of good water. 2500 w. Engr, Lond—Jan. 21, 1898. Serial. 1st part. No. 18118 A.

Cyanid Process.

Contributions to the Chemistry of the Cyanid Process. William Skey. Discusses how the cyaniding of gold is effected, the actual chemical decompositions that occur in the process, &c. 5000 w. N Z Mines Rec—Jan. 17, 1898. Serial. 1st part. No. 18415 B.

The Stamp Milling of Gold Ores in its Relation to Cyaniding. E. H. Johnson. Points out some things in milling practice which militate against the successful treatment of tailings and slimes. 1300 w. Chem & Met Soc of S. Africa—Dec. 18, 1897. No. 18130 D.

Dry Separation.

The Dry Separation of Gold and Copper. Franklin R. Carpenter. Explains a separating process recently patented, giving notes of literature examined and experiments made. 1100 w. Eng & Min Jour—Feb. 12, 1898. No. 18368.

Gold Absorption.

Absorption of Gold by Wooden Leaching Vats. Francis L. Bosqui. Gives results of observations tending to show that losses through this cause have been over-estimated. 1000 w. Eng & Min Jour—Feb. 26, 1898. No. 18682.

Gold Formations.

Gold Formation in California. W. H. Storms. Considers the formation of the Sierra Nevada, the great fissure system, faults, veins, gravels, &c., and the needs of the present time in this mining region. 3500 w. Min & Sci Pr—Jan. 29, 1898. No. 18254.

Kalgoorlie.

Kalgoorlie, Western Australia, and its Surroundings. George J. Bancroft. Abstract of paper read at the Atlantic City meeting of the Am. Inst. of Min. Engs. Information of the ores and manner of deposit. 1500 w. Eng & Min Jour—Feb. 19, 1898. No. 18621.

Klondike.

Mining Conditions in the Klondike. Extracts from a letter published in the *N. Y. Times* of Jan. 23d. Discouraging the going to this new gold field, reporting disappointment and suffering of those there, and the unreliability of the claims for sale. 2500 w. Eng & Min Jour—Jan. 29, 1898. No. 18108.

The Yukon Gold Fields. Considers Van couver as a base of supplies, the transportation enterprises, and the situation at Dawson City. 1600 w. Cons Repts—Feb. 4, 1898. No. 18197 D.

Korea.

United States Gold Mine Concession in Korea. Some information relating to the value of the concession granted to James R. Morse for a period of twenty-five years, and other mining interests. 800 w. Cons Repts—Jan. 29, 1898. No. 18091 D.

Mother Lode.

The Mother Lode of California. Ross E. Browne. Locates and describes the lode, the ores, quartz bodies, gold product, treatment of ores, giving cost of production, methods of opening the mines, &c. Ill. 5500 w. Min & Sci Pr—Jan. 29, 1898. No. 18251.

Nuggets.

The Crystalline Structure of Gold and Platinum Nuggets. A. Liversidge. Abstract of a paper read before the Royal Society of N. South Wales. Illustrated description of nuggets from Australia with account of investigations made, showing that gold nuggets have not been built up by successive coatings. 2000 w. Eng & Min Jour—Feb. 19, 1898. No. 18623.

The Origin of Nuggets. A. Liversidge. Illustrated description of nuggets from various sections, with account of investigations. 2000 w. Aust Min Stand—Dec. 30, 1897. Serial. 1st part. No. 18292 B.

Ore Treatment.

Ore Treatment in Boulder County, Colorado. C. C. Burger. Describes a 50-ton chlorination plant and its machinery, which has been in operation six months, its success and its adaptability to tellurium ores. 2400 w. Eng & Min Jour—Jan. 29, 1898. No. 18106.

Placer Mining.

Placer Mining by Machinery. William M. Johnston. Reviews some of the methods adopted which often have resulted in loss, and endeavors to point out lines which may be safely followed. 3000 w. Min & Sci Pr—Feb. 5, 1898. No. 18310.

Quartz Mining.

Beginning of Quartz Mining in California. Almarin B. Paul. Reviews the history from 1848 to the discovery of the Comstock. Ill. 2300 w. Min & Sci Pr—Jan. 29, 1898. No. 18253.

Siberia.

The Natural Resources and Gold Bearing Strata of Siberia (La Sibérie, ses Resources Naturelles et ses Gisements Aurifères.) A review of the recent work by M. R. De Batz, with much interesting and valuable information concerning this important country. 1800 w. Le Génie Civil—Jan. 29, 1898. No. 18513 D.

Silver Mines.

Silver Cliff District. Arthur Lakes. A description of a unique geological occurrence, and of the Racine Bay, Silver Cliff, Geyser, John Jay, and other mines, and of peculiar outbursts of carbonic-acid gas. Ill. 2000 w. Mines & Min—Feb., 1898. No. 18348 C.

Smelting.

The Influence of Altitude on Smelting. Herbert Lang. An explanation of the increased fuel consumption found necessary in smelting at high altitudes. 800 w. Eng & Min Jour—Jan. 29, 1898. No. 18107.

Stamp Mills.

Origin of the California Stamp. C. P. Stanford. An account of the early mills used and the first California stamp-mill, with the principa improvements. Ill. 3500 w. Min & Sci Pr—Jan. 29, 1898. No. 18252.

Ural.

The Kotchkar Gold Mines, Oural Mountains, Russia. H. B. C. Nitze and C. W. Purington. Abstract of paper read at Atlantic City meeting of the Am. Inst. of Min. Engs. Describes these mines of eastern Russia and the manner of working. 2200 w. Eng & Min Jour—Feb. 19, 1898. No. 18620.

West Kootenay.

Mining Machinery in the Slocan. Howard West. Read before the meeting of the Brit. Col. Assn. of Min. Engs. Gives information of this division of West Kootenay and the machinery now in use. The writer thinks the district is destined to become a marvellous producer of the precious metals. 4000 w. Can Min Rev—Jan., 1898. No. 18086 B.

Some West Kootenay Ore Bodies. J. C. Gwillin. Read at meeting of Brit. Col. Assn. of Min. Engs. Gives analysis of the country rocks, and observations on the ore bodies of this district. 3000 w. Can Min Rev—Jan., 1898. No. 18087 B.

Witwatersrand.

The Gold Mines of the Witwatersrand, South Africa. John Hays Hammond. Mr. Hammond's second paper deals with the methods of working as well as the probable value and approximate duration of the gold supply, together with an account of the mining laws of the region. 2500 w. Engineering Magazine—March, 1898. No. 18590 B.

IRON AND STEEL.

Armor.

American and European Armor Compared. W. L. C. From a paper by Captain O'Neil filed with the Senate Committee on Naval Affairs, discussing the relative superiority of American armor plate over that manufactured by the leading European firms. 3500 w. Ir Age—Feb. 10, 1898. No. 18316.

Basic Steel

Basic Refined Steel on the Continent. C. E. Stromeyer. From a paper read before the Institution of Engineers and Shipbuilders in Scotland. Discusses the three basic processes, and explains how far the basic refining process differs from that of the Thomas open-hearth, and farther operations on the refined steel. 5800 w. Col Guard—Jan. 28, 1898. No. 18271 A.

Bending Tests.

Bending Tests of Iron and Steel Rails. Alfred Chatterton. Describes experiments undertaken originally to ascertain the loads old rails could safely carry, but the experiments were extended and the conclusions reached that in iron rails there is a gradual deterioration rendering them unfit for service; and that the effect on steel rails is to decrease their ductility and diminish their power of resisting deformation. Ill. 1500 w. Ind Engng—Jan. 8, 1898. 2 parts. No. 18390 D each.

By-Products.

The Recovery of By-Products of the Blast Furnace. A. Humboldt Sexton. A review of the various methods employed for the recovery of pitch, oil, paraffin and sulphate of ammonia from the discharge gases of blast furnaces; with reference to the practical operation of plants in the west of Scotland. 3500 w. Engineering Magazine—March, 1898. No. 18597 B.

Cast Iron.

The Effect of Ferro-Sodium on Cast Iron. Walter J. May. An account of the writer's experience with these fluxes. 800 w. Prac Eng—Jan. 28, 1898. No. 18296 A.

Gas Producers.

An Automatic Feed-Device for Gas Producers. C. W. Bildt. An illustrated description of a feed-device constructed and patented by the writer which has given satisfaction. 2200 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18466 D.

Modern Types of Gas Producers. Part first is largely introductory, discussing the use of gas for industrial purposes, the processes for making gas which have recently come into use, and commences the consideration of the different types of producers. Descriptions of the Thwaite duplex producer and the Thwaite single vessel producer are given. 3200 w. Ir & Coal Trds Rev—Jan. 21, 1898. No. 18163 A.

Ingots.

The Defects of Steel Ingots. (Les Défauts des Lingots d'Acier.) A critical study of the defects caused by over or underheating, sudden cooling, and variations in composition, together with an account of the influence of pressure, and the best precautions to be observed to obtain satisfactory results. Two articles. 7000 w. Le Génie Civil—Jan. 15, 22, 1898. No. 18508. G.

Iron Trades.

English and American Methods in the Engineering and Iron Trades. From presidential address of Henry Webb before the Manchester, (Eng.), Assn. of Engs., contrasting the methods, and suggesting various directions where American methods might be introduced with economy. 2200 w. Engr, Lond—Jan. 21, 1898. No 18119 A.

Pig Iron.

Notes on the French Pig Iron Industry. (Mittheilungen über die Französische Roheisenindustrie.) A tabular review of French iron production by departments, compared with that of other countries. 6000 w. Stahl und Eisen—Jan. 15, 1898. No. 18569 D.

The French Pig Iron Industry. From an article by Oscar Simmersbach in *Stahl und Eisen*. Information of the scarcity of material and inferior quality, &c. 1300 w. Am Mfr & Ir Wld—Feb. 11, 1898. No. 18357.

The Location of Pig Iron Production in the United States. Gives figures showing that the center of pig-iron production has passed to the Central West—the district of Pittsburg, Cleveland and Chicago. 1200 w. Eng & Min Jour—Feb. 26, 1898. No. 18681.

Plates.

Appliances for the Manufacture of Ship and Boiler Plates. Illustrated description of metal-working machines for billet-shearing, slab-shearing, and plate-shearing. 800 w. Ir & Coal Trds Rev—Jan. 28, 1898. No. 18279 A.

Review.

The Metallurgy of Steel in 1897. (La Métallurgie de l'Acier en 1897.) A. Boudon. A general review of the progress of the past year, dealing with details of new processes. Serial. 1st part. 4000 w. La Revue Technique—Jan. 25, 1898. No. 18529 D.

Stockholm Exposition.

The Stockholm Exposition and the Iron and Steel Trade of Sweden. James Douglas. Abstract of paper read at the Atlantic City meeting of Am. Inst. of Min. Engs. Describes the interesting exhibits of the iron and steel industries. 1500 w. Eng & Min Jour—Feb. 19, 1898. No. 18622.

Tool Steel.

Handling Tool Steel. S. K. Stupakoff. Urging the use of a reliable pyrometer, free intercourse between steel maker and steel worker, making it compulsory that an analysis should be furnished, and information on all points of service to the steel worker. 2400 w. Ir Age—Feb. 17, 1898. No. 18441.

MINING.

Accidents.

Prevention of Accidents. An essay by M. G. Thomas, awarded first prize at an eisteddfod held at Oskaloosa, Iowa, Dec. 25, 1897. The best method of preventing accidents in and about the mines of Iowa. 2500 w. Mines & Min—Feb., 1898. No. 18350 C.

Automatic Doors.

Automatic Interlocking of Two Air-Doors. M. Botton. From a communication to *Comptes Rendus Mensuels* of the Société de l'Industrie Minerale, Saint Etienne. In the apparatus shown, the doors open in the same manner as two ordinary doors, although they cannot both be opened at the same time. 700 w. Col Guard—Jan. 28, 1898. No. 18273 A.

Improvements in Automatic Trap Doors for Mine Shafts. (Ueber Neuerungen an Bremsschachtverschlussen.) Illustrating several devices for operating the doors automatically by the action of the cage; as used in a number of the mines of the Westphalia district. 2500 w. 2 plates. Glückauf—Feb. 5, 1898. No. 18572 B.

Capell Fan.

The Capell Fan. Some results obtained at a test conducted by the Berwind-White Coal-Mining Co., at Windber, Somerset Co., Penn. Ill. 3000 w. Mines & Min—Feb., 1898. No. 18352 C.

Explosives.

The Storage of Explosives. Robert Hunter. Gives sets of plans and specifications which have met with approval, and discusses the site and ventilation. Ill. 2500 w. Col Guard—Feb. 11, 1898. No. 18601 A.

The Various Systems of High Explosives, and the Conditions of Their Economical Application to the Different Methods of Working Coal in the British Collieries. L. T. O'Shea. The prize essay of this paper. Part first deals with the composition, safety, flames, &c. 3000 w. Ir & Coal Trds Rev—Feb. 4, 1898. Serial. 1st part. No. 18385 A.

Faults.

Faults. Albert Williams, Jr. Recovery of faulted beds and veins, relation of folds to faults and of both to metalliferous deposits, practical hints, &c. Ill. 6500 w. Mines & Min—Feb., 1898. No. 18349 C.

Fire.

The Fire in the Consolidated Cleophas Mine in Upper Silesia, March 3, 1896. (Der Brand in der Konsolidièrten Cleophas Grube in Oberschlesien am 3 März 1896.) With an account of the successful use of steam and water for subjugating a stubborn fire in a gaseous mine. 2500 w. Glückauf—Feb. 12, 1898. No. 18573 B.

Locating Claims.

Location Before Discovery. R. W. Raymond. A consideration of the arguments opposing the location of claims on public mineral lands of the United States without proof of discovery within the claim of a valuable mineral deposit, with statements defining the situation. 1700 w. Eng & Min Jour—Feb. 12, 1898. Serial. 1st part. No. 18365.

Mexican Mining.

Mexican Methods of Mining. S. B. Newall. Abstract of a paper read before the Institution of Mining and Metallurgy, London. Describes the methods of working, and their adaptation to the majority of Mexican mines. 1700 w. Col Guard—Jan. 28, 1898. No. 18274 A.

Mining Appliances.

Engineering Appliances in Mining. C. M. Percy. Read before the Manchester (Eng.) Assn. of Engineers. The work of the mechanical engineer in the industry of coal mining, indicating the branches in which his influence has been most effectively applied, and the lines for further improvement. Discussion. 4000 w. Col Guard—Feb. 4, 1898. No. 18379 A.

Mining Camps.

Northwestern Mining Camps. W. B. Turner. A description of Stevens Co., and the Colville Reservation in Washington, U. S. A., and the Trail Creek and Nelson Districts, British Columbia. 2000 w. Mines & Min—Feb., 1898. No. 18351 C.

Mining Law.

Mining Law and Its Bearing on the Development of Mines and Mining Districts. Frank C. Loring. Paper read at meeting of the B. C. Assn. of Min. Engs. Historical review of laws in various lands regarding ownership and right to dispose of mines, reviewing quite extensively the conditions existing in the United States, with the special object of considering the state of affairs in British Columbia. 7500 w. Can Min Rev—Jan., 1898. No. 18085 B.

Mining Law in British Columbia, Mexico and the United States. Rossiter W. Raymond. A general summary by the secretary of the American Institute of Mining Engineers intended to afford a basis for comparison with other countries, and especially with the laws of South Africa. 2500 w. Engineering Magazine—March, 1898. No. 18591 B.

Provision for Dead Rents in Mining Leases. Explaining British law on this subject. 2400 w. Col Guard—Jan. 21, 1898. No. 18137 A.

United States Mining Laws, and Regulations Thereunder, Relative to the Reservation, Exploration, Location, Possession, Purchase and Patenting of the Mineral Lands in the Public Domain. The latest official compilation of Federal Mining Law. 3500 w. Min & Sci Pr—Feb. 19, 1898. Serial. 1st part. No. 18651.

Mining Life.

Recollections of California Mining Life. Reviews what is known of the occurrence of gold in California prior to Jan., 1848, gives interesting account of the finding of the gold as reported by various persons, and the effect of the discovery. Ill. 9800 w. Min & Sci Pr—Jan. 29, 1898. No. 18255.

Mining Methods.

Early Mining and Milling Methods in California. R. B. Noyes. Describes the primitive construction of a mill used in the early '50s. 1200 w. Min & Sci Pr—Jan. 29, 1898. No. 18256.

Mining Regulations.

The Mining Regulations for the Canadian Yukon. The new regulations governing placer mining and dredging of this district in Canadian territory. 4400 w. Eng & Min Jour—Feb. 5, 1898. No. 18220.

Respirator.

Respiratory Apparatus for Rescue Work in Mines. J. Mayer. From *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Considers the classification of rescue apparatus, its importance to the mining industry, and gives illustrated description of design constructed by O. Neupert's Successors (Vienna), in conjunction with J. Pilar. 2300 w. Col Guard—Feb. 11, 1898. No. 18602 A.

Shafts.

Warming the Air of a Damp Downcast Shaft; for Preventing the Formation of Ice. M. Petit. From a communication to the Société de L'Industrie Minérale. Reviews the methods in general use and their shortcomings, and explains method worked out by the writer, and apparatus used. Ill. 1700 w. Col Guard—Jan. 21, 1898. No. 18138 A.

MISCELLANY.

Albertite.

Notes on the Albertite of New Brunswick. Ill. John Rutherford. A description of the result of the mining operations at the Albert mine, which supports the opinion that the albertite was injected into an open fissure, when in a very fluid state. 2800 w. Can Min Rev—Jan., 1898. No. 18088 B.

Asbestos.

On the Strange Singularity of Color in Some Forms of Asbestos. Robert H. Jones. Contains information as to the colored varieties of asbestos, especially the blue variety which comes from the Cape of Good Hope. 4400 w. Can Min Rev—Jan., 1898. No. 18089 B.

Asia Minor.

Emery, Chrome-Ore and Other Minerals in the Villayet of Aidin, Asia Minor. W. F. A. Thomae. An account of some of the minerals occurring in this district, describing the general features and geology of the region. Ill. 4800 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18471 D.

Clays.

The Ultimate and the Rational Analysis of Clays and Their Relative Advantages. Heinrich Ries. A discussion of the rational analysis of clay, briefly referring to the ultimate analysis, giving table. 2000 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18467 D.

College of Mines.

The Michigan College of Mines. M. E. Wadsworth. An account of the aim and work of this institution. 5300 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18473 D.

Engineering Education.

Some Statistics of Engineering Education. M. E. Wadsworth. Statistical tables containing data from 1874 to date, with running commentary calling attention to certain points. 4000 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18472 D.

Geologists.

Eminent American Geologists. J. L. Norris. Read at meeting of Ohio Inst. of Min Engs. Briefly reviews the work undertaken by geologists, and gives brief sketches of American geologists of note. 2800 w. Am Mfr & Ir Wld—Jan. 28, 1898. No. 18102.

Limonite Pseudomorphs.

Note on Limonite Pseudomorphs from Dutch Guiana. R. W. Raymond. Description and analysis of specimens of peculiar pseudomorphs of limonite after pyrite, found in the auriferous deposits of the Saramacca district. 1700 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18468 D.

Manganese.

A Peculiar Manganese Ore of the Amazon District. (Ein Eigenthümliches Manganerz des Amazonas-Gebietes.) Dr. F. Katzer. Describing a peculiar nodular form of Limonite, which is associated with Psilomelane and Pyrolusite, and which occurs in the Amazon valley in sufficient quantity to be of commercial value. 3000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 22, 1898. No. 18574 B.

Ore Reserves.

Calculating and Recording the Value of Ore Reserves. John Clince Little. Paper read before the British Soc. of Min. Students. Suggests the use of a slide-scale for calculations of value, cost, profit, or loss, illustrating the method of working by an example. 2200 w. Can Min Rev—Jan., 1898. No. 18090 B.

Ores.

Lead and Zinc Ores. E. Hedburg. The manner of their occurrence and their geological relation to the coal area of Missouri. Ill. 1400 w. Mines & Min—Feb., 1898. No. 18346 C.

Petroleum.

The Petroleum Sources of the British Empire. Boverton Redwood. Abstract of a paper read before the Imperial Institute. Information of the various fields in the British Empire, and the value of the deposits. 4500 w. Col Guard—Feb. 4, 1898. No. 18381 A.

Salt.

Soóvár (Sóovár). G. Harmancsok. A geological and historical account of the Soóvár salt mines in Galicia, in which electric power has recently been introduced. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 12, 1898. No. 18577 B.

The Salt Mines of the Alps at the End of the 19th Century. (Die Salzberge der Alpen am Ende des Neunzehnten Jahrhunderts.) A general review of the history of the Alpine salt industry, with an account of the geological conditions, the present output, and future prospects. Two articles. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 5, 12, 1898. No. 18576 E.

Soda Deposit.

Native Sodium Carbonate. W. P. Blake. Information concerning a deposit near the head of the Gulf of California, known as the Santa Helena Soda Deposit. 800 w. Eng & Min Jour—Feb. 12, 1898. No. 18366.

Statistics.

The Statistics of the Mineral Industries of France for the year 1896. (Statistique des Industries Minérales en France pour l'Année 1896.) An abstract from the official report, giving the data for coal and iron, as well as such other minerals as occur in France; together with condensed information concerning steam engines. 1500 w. Le Génie Civil—Jan. 15, 1898. No. 18509 D.

Tin Works.

Some Products Found in the Hearth of an Old Furnace, upon the Dismantling of the Trethellan Tin Works, Truro, Cornwall. Wm. P. Headden. The furnaces had probably been in use nearly one hundred years, and the ores melted in them were the usual Cornish tin-ores, carrying some arsenopyrite. 1400 w. Am Jour of Sci—Feb., 1898. No. 18128 D.

Tungsten Ores.

Tungsten Ores in N. S. W. Joseph E. Carne. Memoranda respecting the occurrence in this colony. No payable deposits have yet been discovered. 3800 w. Aust Min Stand—Jan. 6, & 13, 1898. Serial. 2 parts. No. 18417 A each.

United Kingdom.

Mineral Statistics. A criticism on the report of mineral statistics of the United Kingdom, discussing the method of presentation, &c. 3500 w. Builder—Jan. 22, 1898. No. 18162 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene Explosions. Surveys some of the principal accidents that have occurred, discussing the cause, and giving information. 1800 w. Sci Am—Feb. 5, 1898. No. 18170.

An Acetylene Gas Generator. Illustrated description of Kay's patent safe acetylene gas generators. 1400 w. Col Guard—Feb. 4, 1898. No. 18380 A.

Burners for Acetylene Gas. (Ueber Acetylenebrenner.) A. Weber. With diagrams and curves showing the illuminating efficiency of various burners adapted for use with acetylene. 2000 w. Schweizerische Bauzeitung—Jan. 29, 1898. No. 18557 B.

Address.

Inaugural Address Before the Southern District Association of Gas Engineers, England. R. Beynon. Deals with experiences met with in the Torquay gas-works. 6000 w. Gas Wld—Feb. 12, 1898. No. 18489 A.

Ammonia.

The Value of Sulphate of Ammonia Compared with Other Manures. Information gained at Lord Rosebery's experimental station at Dalmeny, from the series of agricultural experiments carried out on these grounds. 1700 w. Jour of Gas Lgt—Feb. 1, 1898. No. 18400 A.

Calcium Carbid.

Priority in the Discovery of a Commercial Method of Making Calcium Carbid. Arthur C. Fraser. Evidence in support of the statement that the discovery belongs to the United States. 3800 w. Pro Age—Feb. 1, 1898. No. 18177.

Chemical Processes.

Chemical Processes in Gas-Works. W. Leypold. Abstract of a lecture given at the general meeting of the Assn. of German Chemists at Hamburg. 2000 w. Jour Gas Lgt—Feb. 1, 1898. Serial. 2 parts. No. 18399 A each.

Conveyor.

The Brouwer Quenching Conveyor of the Gas Works at Saint-Quentin and Fontainebleau, France. Translated from *Journal des Usines à Gaz.* Illustrated account of operation. 500 w. Pro Age—Feb. 1, 1898. No. 18176.

Gas Improvements.

A Berlin Deputation. Abstract of the chief points of report given by a deputation sent on a circular tour to look into the question of coin meters and other improvements, particularly with reference to carburetted water gas. 2000 w. Gas Wld—Feb. 5, 1898. No. 18403 A.

Illumination.

Investigation of Diffused Illumination for School-rooms, Lecture Halls and Work-rooms by Means of Incandescent Gas Lights. F. Kermauner and W. Prausnitz. Investigates the proper distribution of lamps and the number which ought to be used. 2500 w. Pro Age—Feb. 1, 1898. No. 18178.

Incandescent Lighting.

Development of Incandescent Gas Lighting in the United States. D. Walter Brown. A concise history of the subject in title, with patents related thereto. 1300 w. Pro Age —Feb 15, 1898. Serial. 1st part. No. 18414.

Leaks.

The Bouvier System for Detecting Leaks in Gas Mains. An illustrated description of this system which consists essentially of an inverted siphon placed in the gas main at the end of each section occupying a definite district. Describes the method of testing. 1200 w. Pro Age—Feb. 1, 1898. No. 18179.

Lighting.

Automatic Gas Lighting. (Gasfernzundung.) Discusses the various methods of turning on and lighting a number of gas burners from a distant point. Electro-magnetic valves and platinum sponge lighters are described. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 5, 1898. No. 18553 D.

Light Standards.

Some Remarks on Standards of Light. Remarks on the difficulties in photometry and the need of a more reliable standard by which to have the public gas supply valued. 1500 w. Jour Gas Lgt—Feb. 1, 1898. No. 18398 A.

Mantles.

Brilliancy of Incandescent Mantles for Gas Lighting. C. Killing. Experiments and conclusions drawn of the results. 2000 w. Gas Engs' Mag—Feb. 10, 1898. No. 18679 A.

Philadelphia Gas Works.

The Arguments on the Appeal in the Matter of the Lease of the Philadelphia Gas Works. An examination of the arguments. 2000 w. Am Gas Lgt Jour—Feb. 7, 1898. No. 18246.

Purification.

Heat Developed During Purification. J. P. Gill. Presents a method of determining what will be the temperatures caused by the chemical reactions of the mass in the purifier and when removed therefrom. 1700 w. Am Gas Lgt Jour—Jan. 31, 1898. No. 18104.

The Progress of Purifier Construction and Operation, with an Instance. H. A. Mather. Describes and illustrates the system designed and erected by Henry M. Greene of the Preston (England) gas works. 2800 w. Am Gas Lgt Jour—Feb. 21, 1898. No. 18619.

Revivification.

The Heat of Revivification of Oxid. A critical review of paper by Herman Poole, published in the Am. Gas. Lgt. Jour. 1800 w. Jour Gas Lgt—Feb. 15, 1898. No. 18650 A.

Tar Still.

Lennard's Continuous Tar Still. From *The Chemical Trade Journal.* Illustrated description of an arrangement intended to do away with the odors. 800 w. Pro Age—Feb. 15, 1898. No. 18413.

Water Gas.

Developments in the Manufacture and Use of Water Gas. H. Dicke. States the advantages of water gas, discusses the Dellwik process and the manner in which water-gas works can meet the requirements of city use. 2300 w. Gas Wld—Jan. 22, 1898. No. 18159 A.

Welsbach.

The French Welsbach Patent Investigation. MM. Friedel and Bardy. Translated from the *Journal de l'Eclairage au Gaz.* Investigations of the specifications and patent claims of the Auer patents. 900 w. Pro Age—Feb. 1, 1898. No. 18180.

SEWERAGE.

Collector.

The Collecting Sewer on the Right Bank of the Danube Canal at Vienna. (Der Sammelcanal am Rechten Ufer des Donau canales in Wien.) An account of the inspection of this important work by the Austrian Society of Engineers, with photographs illustrating work in progress. 3000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Jan. 28, 1898. No. 18540 B.

Intercepting Sewers.

Intercepting Sewers in 12th St. and 22d St., Chicago. Illustrated description of the first two sewers of the intercepting system which is to carry the sewage to the Chicago River. 2000 w. Eng News—Feb. 24, 1898. No. 18659.

Pumping Engine.

A Sewage Pumping Engine at Charlottenburg, Germany. From *Zeitschrift d. Ver. Deutscher Ingenieure.* Illustrated description. 500 w. Eng News—Feb. 24, 1898. No. 18655.

Purification.

The Purification of City Sewage. (Die Klärung Städtischen Abwässer.) Abstract of a paper by Herr Brix, of Hamburg, reviewing the various sedimentation and precipitation processes, and emphasizing the importance of adapting the method to the local conditions. 1800 w. Gesundheits Ingenieur—Jan. 15, 1898. No. 18555 B.

The Purification of Sewage. Editorial on the experiments being tried at Exeter, Eng., with information concerning recent systems. 2500 w. Engng—Jan. 21, 1898. No. 18134 A.

Sewage Disposal.

Sewage Disposal and Stream Pollution in the Lower Passaic Valley, New Jersey. Editorial on the situation in the lower Passaic Valley, with some of the proposals for the solution of the question. 2000 w. Eng News—Feb. 24, 1898. No. 18658.

The Sewerage of Wimbledon, England. James H. Fuertes. Illustrates a system where none of the sewage, not even storm-water overflow, is allowed to flow directly into water courses. 1200 w. Eng Rec—Feb. 12, 1898. Serial. 1st part. No. 18360.

Sewage Works.

The Leyton Sewage and Destructor Works. Illustration of works, with description of process. 1300 w. Engr, Lond—Feb. 4, 1898. No. 18378 A.

STREETS AND PAVEMENTS.

Brick Pavements.

Random Notes on the Construction of Brick Pavements. E. A. Kemmler. Reviews the principles of street construction as laid down by the different specifications of a number of the larger cities, pointing out the good and bad features. 2400 w. Munic Engng—Feb., 1898. No. 18121 C.

Westminster.

Westminster Improvement Scheme. Discusses the proposal for rebuilding a portion of the Westminster neighborhood on a large scale, the conditions of which are embodied in a Bill under the title of "The Victoria Embankment and Certain Street Improvements, etc." 3500 w. Builder—Jan. 29, 1898. No. 18289 A.

WATER SUPPLY.

By-Pass.

The Ridgewood Reservoir By-Pass. Illustrated description of this work in Brooklyn. The by-pass main is 5-ft. in diameter. 900 w. Eng Rec—Feb. 26, 1898. No. 18672.

Coolgardie Pipe Line.

Plans of English Engineers for the Coolgardie Pipe Line. Editorial discussion of the plans proposed for a water supply to this mining district in Western Australia. The engineering problem is stated and discussed. 3000 w. Eng News—Feb. 17, 1898. No. 18460.

Croton Dam.

The Croton River Dam, New York Water Supply. Illustrated description of this extensive engineering work. 1700 w. Sci Am—Feb. 5, 1898. No. 18169.

Excavator.

Bomford and Evershed's Patent Excavator. Illustrated description of machine especially suitable for reservoir work, and applicable also to any situation where the spoil has not to be transported a great distance. 1200 w. Engr, Lond—Feb. 11, 1898. No. 18484 A.

Filtration.

The Albany Filtration System. Describes the 15,000,000 gallon covered sand-filter plant to be built at Albany, N. Y. 1500 w. Eng Rec—Jan. 29, 1898. No. 18148.

The New Sedimentation Basin and Masonry Covered Sand Filter Beds at Albany, N. Y. An illustrated description with specifications for filtering material, of what will be the largest water-purification plant in the United States. 1600 w. Eng News—Feb. 10, 1898. No. 18320.

Force Mains.

The Design of Force Mains. Describes a method of determining the most economical diameter of force mains used at Brockton, Mass. 1300 w. Eng Rec—Feb. 19, 1898. No. 18635.

Philadelphia.

Philadelphia Water Supply. Editorial on the situation of the water supply and the plans of the Schuylkill Valley Water Co. 900 w. Eng Rec—Feb. 19, 1898. No. 18631.

Pollution.

The Pollution of the Water Supply of Cumberland, Md., by a Paper Pulp Mill. Churchill Hungerford. Describes the forms of contamination from the process used and gives brief summary of suit by the city of Cumberland, Md. 1400 w. Eng News—Feb. 10, 1898. No. 18319.

Pumping Engine.

A Special Water-Works Pump—Liverpool, England. Joseph Parry. Illustrated description of this unique 7¼ million-gallon engine. 1600 w. Eng Rec—Feb. 26, 1898. No. 18673.

Record System.

The Record System of the Water-Works Department, Detroit. Illustrates a method of keeping pipe records by note books and tracings. 2000 w. Eng Rec—Feb. 12, 1898. No. 18359.

St. Louis, Mo.

Water Works of St. Louis. Illustrated description of works for a city having an average daily consumption of 55,000,000 gallons. 1700 w. Fire & Water—Feb. 12, 1898. Serial. 1st part. No. 18344.

Water Rates.

The Chillicothe Water-Works Case. Henry Wollman. Reviews an important suit concerning water rates. 800 w. Eng Rec—Feb. 5, 1898. No. 18214.

The Denver Water-Rates Case. Abstract of an unusually important decision concerning rates to private consumers. 1100 w. Eng Rec—Feb. 26, 1898. No. 18674.

Water Sources.

The Investigation of Subterranean Water Sources. (Recherche des Eaux Souterraines.) Discussing the geological conditions which govern the flow of waters within the earth and of the external indications by means of which they may be discovered. Serial. 1st part. 3000 w. La Revue Technique—Jan. 25, 1898. No. 18528 D.

MISCELLANY.

Bacteriology.

The James Forrest Lecture on Bactericlogy. A review of Dr. G. S. Woodward's address before the Institution of Civil Engineers. 2000 w. Eng Rec—Jan. 29, 1898. No. 18147.

Boston.

The Municipal Service of Boston. Francis C. Lowell. The article considers what we get from the city and what we pay for it, taking the city of Boston as an example. 7000 w. Atlantic M—March, 1898. No. 18609 D.

Destructors.

The Berlin Investigations of Dust-Burning. (Die Müllverbreunungs-Versuche in Berlin.) Abstract from the report of Messrs. Bohm and Grohn, with tabulated statement of the cost and performance of the various destructor furnaces tested. 3500 w. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1898. No. 18563 D.

Refuse.

The Cremation of Dust-Bin Refuse. Editorial on the discussion of George Watson's paper on refuse destructors, read before the Gloucestershire Engineering Society. 1500 w. Engng—Feb. 11, 1898. No. 18480 A.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in 1897. Tabulated report of the accidents for the year in the United States. 500 w. R R Gaz—Feb. 11, 1898. No. 18331.

European Railways.

An American Observer in Europe. E. L. Corthell. Names features of English roads superior to the United States, and compares American and European transportation methods. 1200 w. R R Gaz—Feb. 11, 1898. No. 18325.

Rating.

Tonnage Rating. L. R. Pomeroy. Deals with the methods of rating locomotives and the possibilities of reducing their relative consumption of coal. Also discussion. 15500 w. N. Y. R R Club—Jan. 20, 1898. No. 18343 D.

FINANCIAL.

Consolidation.

Consolidation of the "Vanderbilts." Editorial on the proposed consolidation of the New York Central and Lake Shore and Michigan Southern, and other contemplated changes. 700 w. Ry Age—Feb. 4, 1898. No. 18221.

Japan.

Railway Enterprise in Japan. Extract from the *Japan Times*, showing the progress of railway enterprises in Japan during the year 1897. 900 w. Cons Repts—Feb. 17, 1898. No. 18452 D.

Motive Power.

Business Problems of the Motive Power Department. Robert Quayle. Extracts from a lecture delivered at Purdue Univ. Presents an idea of the expenses, and discusses the problems within the department named. 3700 w. R R Gaz—Feb. 18, 1898. No. 18465.

Prussia.

The Budget of the Royal Prussian State Railway Administration for 1898-99. (Der Etat der Königlich Preussischen Eisenbahn-Verwaltung für das Jahr 1898-99.) Giving tabular estimates for the coming year in comparison with those of the past, with details of proposed expenditures and operations. 8000 w. Stahl und Eisen—Feb. 1, 1898. No. 18570 D.

Railroad Building.

Railroads Building or Projected in the United States, Canada and Mexico. List of such enterprises as show signs of genuineness, either by

work in progress or by signs that it will soon be begun. 4000 w. R R Gaz—Feb. 11, 1898. No. 18329.

Yukon.

A Railroad to the Yukon. Extract from the *Ottawa Citizen*, concerning a new line of railway to this region. 700 w. Cons Repts—Feb. 4, 1898. No. 18198 D.

LEGAL AFFAIRS.

Commerce Regulation.

Proposed Changes in the Act to Regulate Commerce. Editorial discussion of the bill introduced in the Senate of the United States by Mr. Cullom. 1500 w. Ry & Engng Rev—Jan. 29, 1898. No. 18167.

Ownership.

J. H. Reagan on Government Ownership. Extract from a letter addressed to Congressman Kleberg of Texas. Unfavorable to government ownership, and also favoring legalizing "pooling." 900 w. Ry Age—Feb. 4, 1898. No. 18222.

MOTIVE POWER AND EQUIPMENT.

Coal Cars.

Coal Car, 60,000 lbs. Capacity; N. Y., N. H. & H. R. R. Illustrated description of cars presenting some interesting details. 900 w. R R Car Jour—Feb., 1898. No. 18333.

Seventy-Thousand Pound, Twin-Hopper Coal Cars. Illustrated detailed description. 600 w. R R Gaz—Feb. 4, 1898. No. 18227.

Coil Springs.

Coil Springs for Freight Cars. A report to the Central Railroad Club by Messrs H. C. McCarty, H. F. Ball, and J. R. Petrie. Considers spring space, type of spring, sizes, &c., and summary of recommendations. Ill. 1500 w. R R Gaz—Feb. 18, 1898. No. 18464.

Drawbar.

Yielding Continuous Drawbars for Railway Cars. (Die Nachgiebige Durchgehende Zugstange für Eisenbahnwagen.) H. von Borries. A paper read before the German Society of Mechanical Engineers advocating the introduction of the continuous drawbar of similar construction to that used in the United States. 3500 w. Glaser's Annalen—Jan. 15, 1898. No. 18564 D.

Driving Shoes.

Fitting Up Driving Shoes and Wedges. Ira A. Moore. Directions for the work with illustrations. 2200 w. Loc Engng—Feb., 1898. No. 18173 C.

Granite Car.

Special Granite Car. Illustrates and describes a car of special design. 400 w. R R Car Jour—Feb., 1898. No. 18334.

Kinetic Motor.

The Kinetic Motor. An illustrated description of an independent motor for railway and tramway service. 1400 w. Ry Wld—Feb., 1898. No. 18394 A.

Locomotives.

American Locomotives for Corea. Illustration and dimensions of locomotives to be built by the Brooks Locomotive Works. 600 w. Eng News—Feb. 24, 1898. No. 18660.

Brooks Locomotives for Japan. Illustrated description with dimensions. 800 w. R R Gaz—Feb. 25, 1898. No. 18663.

Compound Consolidation Locomotives for the Ogdensburg & Lake Champlain. Engraving with detailed description of the parts. 500 w. R R Gaz—Feb. 11, 1898. No 18327.

Early Baldwin Locomotives on the Pennsylvania Railroad. C. H. Caruthers. Description, principal dimensions, and illustrations. 1300 w. Loc Engng—Feb., 1898. No. 18174 C.

Glasgow and South Western Four-Cylinder Locomotive. Illustration and particulars. 600 w. Loc Eng—Feb., 1898. No. 18172 C.

Large Locomotives. Editorial on the rapid development that has taken place in locomotive engineering in the last five years. 1600 w. Engr, London—Feb. 4, 1898. No. 18375 A.

Locomotive Laggings. Wallace W. Johnson. Extracts from a paper read at meeting of N. Y. R. R. Club. The importance of protecting the heat radiating surfaces of the American locomotive, and the coverings used. 1500 w. R R Gaz—Feb. 25, 1898. No. 18661.

Locomotives Supplied by British Firms to American Railroads. An account of the locomotives made for American roads in the early part of this century is given in part first. Ill. 2800 w. Engr, Lond—Jan. 21, 1898. Serial. 1st part. No. 18117 A.

Locomotive with Piston Valves—Norfolk and Western Railway. Information concerning a change of a compound to a single-expansion engine attended with interesting and valuable results. Ill. 1500 w. Am Eng & R R Jour—Feb., 1898. No. 18155 C.

Notes on the Determination of the Principal Dimensions of Locomotives. (Considérations Relatives à la Determination des Dimensions Principales des Locomotives.) A comparison of the relations between speed, tractive power, train resistance and engine power, based on actual performances. 2500 w. Le Génie Civil—Feb. 5, 1898. No. 18515 D.

Richmond Ten Wheel Passenger Locomotives—Southern Railway. Illustrated description of two very large and heavy passenger engines. 1000 w. Ry & Engng Rev—Feb. 19, 1898. No. 18628.

Standard Consolidation Freight Locomotive of the Atchison, Topeka & Santa Fé Railway. Illustrated detailed description of a design of John Player. 900 w. Ry & Engng Rev—Jan. 29, 1898. Serial. 1st part. No. 18165.

The Improved Heilmann Locomotive. (Die Neueren Heilmann Lokomotiven.) E. Wasowsky. A general illustrated description of the Heilmann electric locomotive with photographic views, plan, elevation, and section of truck. 3500 w. Elektrotech Zeitschr—Jan. 27, 1898. No. 18582 B.

Three-Cylinder Compound Locomotive for the Jura-Simplon Railway. (Die Dreicylindrige Verbundlokomotive der Jura-Simplon Bahn.) This engine is constructed with a single high-pressure cylinder between the frames, and two outside low-pressure cylinders. Twenty-five

of this type are now under construction for this road. 1 plate. 2000 w. Schweizerische Bauzeitung—Feb. 12, 1898. No. 18559 B.

Two New Grand Trunk Locomotives. Illustrated description of the 10-wheel passenger engines recently adopted as the standard, and principal dimensions of the new standard mogul freight engines. 700 w. R R Gaz—Feb. 11, 1898. No. 18326.

Postal Cars.

New Postal Cars, Chicago & Alton Railroad. Illustrated description of cars of improved design. 700 w. Am Eng & R R Jour—Feb., 1898. No. 18156 C.

School Car.

The Correspondence-School Car. Engraving and description of car for the International Correspondence School of Scranton, Pa. 700 w. Ry Age—Feb. 18, 1898. No. 18614.

Steel Cars.

The Advantages of Steel Cars. Discusses the economies of large steel cars, considering those intended for special service, and also for general interchange. 1600 w. Am Eng & R R Jour—Feb., 1898. No. 18157 C.

Wheel Testing.

Testing Car Wheels. From a pamphlet issued by the New York Car Wheel Works, of Buffalo, N. Y., entitled: "A Series of Tests Made by the P. H. Griffin Machine Works, of Buffalo, N. Y., on Nov. 8, 1895, with Special Qualities of Wheels Made by the New York Car-Wheel Works." Illustrated description. 2500 w. Foundry—Feb., 1898. No. 18262.

PERMANENT WAY, BUILDINGS AND FIXTURES.

Angle Plates.

High Carbon Angle Plates—Continuous Rails. A letter from A. Torrey, of the Michigan Central R. R., containing valuable facts concerning elastic track. 1000 w. R R Gaz—Feb. 18, 1898. No. 18463.

Ballasting.

Ballasting and Filling with the Rodgers Ballast Car. Illustrated description of car and manner of working. 1500 w. Eng News—Feb. 17, 1898. No. 18457.

Brazil.

The Railways of Brazil. Information relating to mileage, gauge, equipment, etc. 3300 w. Cons Repts—Feb. 14. 1898. No. 18340 D.

China.

Railways in China. (Eisenbahnen in China.) A general review of the progress of railway construction in China since 1875, with map. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 28, 1898. No. 18541 B.

Concord Shops.

Concord Shops—Boston & Maine Railroad. Description and plans of new, well-equipped shops. 2000 w. Am Eng & R R Jour—Feb., 1898. No. 18154 C.

Landslides.

Railway Building and Reconstruction Work in Sliding Ground. (Ueber Eisenbahnbau und Reconstructionsarbeiten in Rutschterrain.) Soulavy & Schmit. An important discussion of the nature of landslides in connection with the geological formation, with examples of original and reconstruction work in various parts of Europe. Three articles. 12000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Jan. 7, 14, 21, 1898. No. 18538 G.

New Line.

The Croydon and Redhill New Line. An account of the new section which will enable the London, Brighton, and South Coast Railway Co. to run entirely over its own lines, instead of using the six miles of the South-Eastern Railway. 1200 w. Engr, Lond—Jan. 28, 1898. No. 18275 A.

Rails.

Rails, Past and Present. E. C. Potter. Read before the Western Railway Club, Chicago. Reviews the early history of steel rails in America, and considers features, which, though apparently trivial, cause much annoyance and unnecessary expense. Ill. 2800 w. Ir Age—Feb. 17, 1898. No. 18442.

Railway Building.

Railway Building in the United States in 1897. Detailed statement by States showing the number of miles of track laid. 2500 w. Ry Age—Feb. 11, 1898. No. 18404.

Siberia.

Notes on the Extension of Railways in Russian Central Asia and Siberia. (Mittheilungen über den Ausbau der Eisenbahnen in Russisch-Central-Asien und Sibirien.) F. Theiss. With map showing the connection of the Transiberian railway with the general Russian system. 1800 w. Glaser's Annalen—Jan. 15, 1898. No. 18565 D.

Signals.

The Connections of the Siemens' Signal System. (Schaltung Siemens'scher Blockwerke.) O. Walzel. Giving schematic diagrams showing the application of the graphical method to the arrangement of block signal systems of Siemens' & Halske. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 21, 1898. No. 18539 B.

Interlocking Plant at Manchester, N. H. Brief illustrated description of the first interlocking plant in the state of New Hampshire. 400 w. Ry Age—Feb. 11, 1898. No. 18405.

Interlocking Signals. An illustrated description of a system for interlocking signals and points of an ordinary third class station designed and patented by H. Sidney Jones, executive engineer. Rajputona-Malwa Railway. 800 w. Ind & East Eng—Jan., 1898. No. 18408 D.

Station.

New East End Canadian Pacific Railway Station at Montreal. Brief illustrated description. 450 w. Ry & Engng Rev—Jan. 29, 1898. No. 18164.

New Terminal Station at Duluth, Minn.; C., St. P., M. & O. Ry. Illustrated description. 500 w. Eng News—Feb. 10, 1898. No. 18318.

The New Grand Central. An illustrated article criticising the inconvenience and poor architecture of the station before alteration, and explaining the improvements made. 1500 w. Harper's Wk—Feb. 5, 1898. No. 18131.

Track Elevation.

Track Elevation in Chicago. Explains the work made necessary by an amendment extending the work about one mile. 1000 w. R R Gaz—Feb. 4, 1898. No. 18228.

Trunk Line.

The Kansas City, Pittsburg and Gulf R. R. Gives the history of the road, location, track, bridges, shops and yards, equipment, terminal, &c. Ill. 5000 w. Eng News—Feb. 17, 1898. No. 18462.

Tunnel.

The Protection of Railroad Traffic Through Tunnels. Charles Hansel. Describes an arrangement lately installed on the Chesapeake & Ohio R. R. for controlling the traffic between the stations of Lowell and Hilldale, Va. A tunnel 6500 ft. long and a bridge 528 ft. long in a distance of 4.2 miles. An absolute block system. 2000 w. Eng News—Feb. 24, 1898. No. 18654.

Victoria.

Economic Railway Construction in Victoria. Maurice Edwin Kernot. Description of the work with analysis of cost per mile. 2300 w. Ind & East Eng—Jan., 1898. No. 18409 D.

TRAFFIC.

Earnings.

January's Large Railroad Earnings. Reports even a better showing than the last month of 1897, and gives tables of comparison. 1500 w. Bradstreet's—Feb. 12, 1898. No. 18354.

Results of the Railroad Year. A comparatively favorable report of the roads of the United States, for the year 1897. 1000 w. Bradstreet's—Feb. 19, 1898. No. 18454.

The Pennsylvania's Latest Earnings. An examination of the statement of this road for Dec., 1897. Shows large increase in gross and net earnings, and the effect on railroad business of the revived activity of trade. 800 w. Bradstreet's—Feb. 5, 1898. No. 18226.

Fares.

British Railway Fares. William J. Stevens. Gives a careful comparison between English and American passenger fares. The very low excursion rates in England are compared with the higher American rates, and the tendency of competition to provide extended facilities is noted. 4000 w. Engineering Magazine—March, 1898. No 18595 B.

Traffic Bureau.

The Traffic Bureau. A. J. Vanlandingham. Substance of an address before the Business Men's League of St. Louis. Explains the work and value of such organizations. 1400 w. Ry & Engng Rev—Jan. 29, 1898. No. 18166.

STREET AND ELECTRIC TRAMWAYS.

Accident Blanks.

Accident Blanks in New Orleans. G. H. Davis. Copy of blank form used by the Canal and Claiborne Railroad Company, with explanatory notes. 1200 w. St Ry Jour—Feb., 1898. No. 18192 D.

Accidents.

Street Railway Accidents. Henry A. Robinson. Abstract of paper read before the Metropolitan St. Ry. Employés' Assn. of New York. Gives a short synopsis of the claim and investigating departments of Metropolitan St. Ry. of N. Y., classifies the accidents and examines the causes, and gives brief advice to conductors. 3300 w. St Ry Jour—Feb , 1898. No. 18193 D.

Accounting.

Open Questions before the Committee on a Standard System of Street-Railway Accounting. A. O. Kittredge. A report of the discussion by the committee appointed by the Assn. of St. Ry. Accountants at Niagara Falls. 3000 w. St Ry Jour—Feb., 1898. No. 18196 D.

Accumulators.

Accumulator Roads. (Akkumulatorenbahnen.) E. Hauswald. A description of the use of the Pollak accumulator system in Frankfort, with load diagram and details of cost and management. 1800 w. Elektrotech Zeitschr—Jan. 20, 1898. No. 18581 B.

Boosters.

Boosters for Street Railways. Describes installations on various roads. Ill. 3300 w. St Ry Rev—Feb. 15, 1898. No. 18450 C.

Brooklyn Bridge.

Trolley-Car Service on the Brooklyn Bridge. Illustrated description of the construction methods employed for the track and overhead equipment. 1000 w. Elec Wld—Feb. 5, 1898. No. 18223.

Changing Power.

Changing a Cable Street Railway to a Conduit-Electric System in Washington, D. C. Describes and illustrates the work. 1800 w. Eng News—Feb. 24, 1898. No. 18653.

Connecticut.

Operating Expenses of Connecticut Railways. From the annual report of Railroad Commissioners indicating a not very prosperous condition. 3500 w. St Ry Rev—Feb. 15, 1898. No. 18449 C.

Electric Tramways.

Electric Tramway Design. Alex McCallum. Considers some of the general principles applying them to a simple line and indicating how their scope may be extended. 4000 w. Ry Wld—Feb., 1898. No. 18395 A.

Electric Traction in America. Louis Bell. A general review of the improvement in American tramway practice, the different systems, costs and future prospects. 3500 w. Ry Wld—Feb., 1898. No. 18396 A.

Mechanical Features of Electric Traction.

Philip Dawson. Read before the Institution of Mechanical Engineers, England. Introductory remarks showing the importance of the subject, with discussion of special features entering into the design and construction of the system. Ill. 2500 w. Elect'n, Lond—Jan. 28, 1898 Serial. 1st part. No. 18294 A.

Exposition.

Competition for an Electric Railway in the Paris Exposition of 1900. (Concours pour un Chemin de Fer Electrique à l'Interieur de l'Exposition de 1900.) Giving the conditions for the competition, and a brief description of the five plans already submitted. 1200 w. Le Génie Civil—Jan. 8 1898. No. 18507 D.

Foresight.

The Value of Foresight in Engineering. Editorial on the announcement of the Third Avenue R. R. Co. of New York City, that electric traction on the conduit system will be substituted for the cable. 1400 w. Eng News—Feb. 3, 1898. No. 18204.

Glasgow Subway.

The Glasgow District Subway. Gives a few details of the general features, the schemes that led up to it, and the reasons for the form it has finally taken, also describing the electric gear used. Ill. 2800 w. Elec Eng, Lond—Jan. 21, 1898. Serial. 1st part. No. 18160 A.

Kansas City.

System of the Metropolitan Street Railway Company of Kansas City. Illustrated detailed description of a system which embraces nearly all the cable and electric lines of Kansas City, Kan., and Kansas City, Mo. 3700 w. St Ry Jour—Feb., 1898. No. 18190 D.

Locomotive.

See Railway Affairs, Motive Power.

London Underground.

London Underground Electric Railroads. Brief review of the lines in operation or in a forward state of construction. 1500 w. R R Gaz—Feb. 4, 1898. No. 18230.

The London "Underground" and Electrical Equipment. The conclusions of the commission appointed by Parliament to inquire into the ventilation of the tunnels of the Metropolitan steam line, with the general characteristics, details of trains, &c. 2200 w. R R Gaz—Feb. 25, 1898. No. 18662.

Massachusetts.

The Report on the Relations of Street Railways and Municipal Corporations in Massachusetts. Text of report of the special committee. 12000 w. St Ry Rev—Feb. 15, 1898. No. 18451 C.

Mountain Road.

Three-Phase Electric Road from Zermatt to the Gornergrat, Switzerland. (Chemin de Fer Electrique à Courants Triphasés de Zermatt au Gornergrat.) A very fully illustrated account of this important electric rack railway. 1 plate. 4500 w. Le Génie Civil—Jan. 22, 1898. No. 18510 D.

The Jungfrau Railway. L. Bayly. Illustrated description of this wonderful electrical engineering work. 1600 w. Elec Eng, N. Y. —Feb. 24, 1898. No. 18641.

Municipal Ownership.

Municipal Ownership of Street Railways in Massachusetts. A report against it by a special investigation committee. 2000 w. Elec Eng, N. Y.—Feb. 10, 1898. No. 18305.

Pittsburgh.

Important Changes Proposed in Pittsburgh. An outline of the important changes in regard to the generation of power, made necessary by the recent consolidation of several companies. Ill. 1000 w. St Ry Jour—Feb., 1898. No. 18195 D.

Rapid Transit.

Rapid Transit in New York. Editorial on the privileges asked by the Manhattan Ry. Co. in the way of extending and improving its system. 1300 w. R R Gaz—Feb. 4, 1898. No. 18231.

Shops.

The Chester Park Shops of the Cincinnati Street Railway Company. Illustrated description of the fine shops built since the consolidation of the street-railway companies into one system. 2000 w. St Ry Jour—Feb., 1898. No. 18191 D.

Storage Battery.

Tests of a Storage Battery Electric Railway Power Plant. An account of tests of the power plant and batteries of the Englewood & Chicago Electric Ry., made by George A. Damon. 3000 w. Eng News—Feb. 3, 1898. No. 18205.

Test of the Chicago Storage Battery Road. A brief sketch of the history of the company and description of the equipment, with account of test. Ill. 6800 w. St Ry Rev—Feb. 15, 1898. No. 18448 C.

Street Railroad Laws.

Proposed Massachusetts Street Railroad Laws. A synopsis of the two bills embodying new laws and amendments to the old ones. 1700 w. R R Gaz—Feb. 25, 1898. No. 18665.

Tunnel.

Views in the Completed Portion of the Boston Rapid-Transit Tunnel. Interesting views of this subway, showing its attractive appearance, with some information relating to tracks, lighting system, station equipment, &c. 1500 w. Eng News—Feb. 3, 1898. No. 18201.

Worm Gearing.

Worm Gearing and Railway Traction. A defence of the method of connecting railway motors to car axles by means of worm gearing. 1100 w. Am Elect'n—Feb., 1898. No. 18244

BOOKS OF MONTH

MECHANICAL DRAFT. A Practical Treatise. B. F. Sturtevant Co., Boston, Mass. Sturtevant Engineering Co., London. 1898.

Although this handsome volume bears the imprint "Catalogue No. 98," it is by no means a trade catalogue in the ordinary acceptance of the term, but in fact a practical treatise of much value upon a subject concerning which there is elsewhere but little information available. The title in itself is hardly an indication of the real contents, since the earlier chapters form a treatise upon the generation of steam, beginning with water and its properties, and discussing successively steam, combustion, fuels and fuel efficiency, boiler efficiency, and rate of combustion, at which point the general subject of draft and its various forms is taken up.

In these early chapters there is a mine of information of great value, thoroughly up to date, collected from sources of the highest authority and tabulated in a very convenient manner, and while in the later portion of the book the advantages of the Sturtevant blower are set forth in connection with the production of mechanical draft, no attempt is made to introduce any form of advertising, and care has been taken to eliminate entirely the element of personal prejudice.

The subject of the advantages of mechanical draft as compared with what has rather oddly been termed "natural" draft is one which is receiving increased attention in many directions, and, from being considered merely as an alternative method, it is beginning to be advocated by many engineers as preferable for nearly all locations and circumstances. Under these conditions such a treatise as that which is before us should be in the library of every mechanical engineer who is interested in steam generation, as the best and, in fact, the only compendium of information relating to mechanical draft yet published.

We desire to take this occasion to commend the able manner in which Mr. Walter B. Snow, who, we understand, is the author of the work, has performed his task, especially in the admirable arrangement of the tabular information.

THE "ELECTRICIAN" ELECTRICAL TRADES DIRECTORY, London: The Electrician Printing and Publishing Company, Limited. 1898.

The sixteenth year of this standard trades directory appears fuller than ever with valuable reference information and data relating to the electrical and allied industries.

The biographical section, which has always been noted for its fulness and accuracy, particularly in regard to contemporaneous scientific men, is this year more complete and valuable than in previous editions; while the main portion of the work, the directory of home, foreign, and colonial workers and dealers in the wide field covered by the electrical trades, is indispensable to all who are engaged in this growing branch of commerce and industry.

BOOKS RECEIVED.

The Marine Steam Engine. A Treatise for Engineering Students, Young Engineers, and Officers of the Royal Navy and Mercantile Marine. By the late Richard Sennett and Henry J. Oram. London, New York and Bombay: Longmans, Green & Co. 1898.

La Photographie et l'Etude des Nuages. Par Jacques Boyer. Paris: Charles Mendel. 1898.

Die Knickfestigkeit in Theorie, Versuch und Praxis. Vortrag des Herrn Fritz V. Emperger, und Discussion hierzu. Wien: Sonderabdruck aus der Zeitschrift des Oesterr. Ingenieur- und Architekten-Vereines. 1897.

The Pneumatic Despatch Tube System of the Batcheller Pneumatic Tube Co., also Facts and General Information Relating to Pneumatic Despatch Tubes. By B. C. Batcheller, B. Sc., M. E. Philadelphia: J. B. Lippincott Co. 1897.

Proceedings of the South Wales Institute of Engineers, Vol. 20, No. 6, containing papers by Mr. Hort Huxham on "Some Local Disturbances in Anthracite Colleries" and one by Mr. E. Cottam on "Coal Getting Without Blasting"; also full discussion on Prof. Galloway's paper on "Subsidence Caused by Workings in Mines."

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Ingersoll-Sergeant Drill Co., New York.=Advance Sheets. Catalogue No. 41, illustrating and describing mining, tunneling, and quarrying machinery. Descriptive tables of the four types of rock drills made by the firm are given, together with directions for ordering and numerous handsome illustrations of practical applications.

General Electric Company, Schenectady, N. Y. =A Modern Gear Plant. A neat little pamphlet describing and illustrating the gear making plant at Lynn for the manufacture of steel gears and pinions for electric traction work.

Lincoln Iron Works, Rutland, Vt.=Circular No. 81; containing handsome illustrations of machines for planing stone; single and double platen planers are shown of capacity up to 8×4×14 feet.

The International Correspondence Schools, Scranton, Pa.=Pamphlet catalogue of letters of endorsement by 88 students, all of whom testify to the value of the correspondence method of instruction.

Baker & Co., Newark, N. J.=Pamphlet catalogue of utensils of platinum for chemical and industrial use; including acid stills, dishes, pans, crucibles, &c., together with valuable data concerning platinum, tables of weights, electrical resistance, and notes concerning the care of platinum articles.

Vulcan Iron Works Co., Toledo, Ohio.=Descriptive Pamphlet of the special trench steam shovel, or back-action excavator; with photographs of the machine in action, and data concerning capacity and speed of operation.

The Ridgely & Johnson Tool Co., Springfield, Ill.=Pneumatic hammers for chipping, calking and riveting; also yoke and pocket pneumatic riveters for structural, tank and stack riveting in place.

Fraser & Chalmers, Chicago.=Riedler Pumps, Compressors and Blowing Engines. A valuable descriptive catalogue of the Riedler system, giving its history, with valve details, and illustrations of many important installations of these improved pumping engines. The data of tests form important engineering records for permanent reference.

The Risdon Iron Works, San Francisco, Cal.=Catalogue No. 7. Air Compressing Machinery and Improved Rock Drills. Illustrating many varieties of compressors both simple and compound; operated by Corliss engines, Risdon water wheels or belt or rope transmission. Valuable tables and formulæ are appended.

Montgomery & Co., New York.=The Tool Catalogue. An illustrated catalogue and price list of supplies, tools and machinery for all branches of the mechanical trades; including small tools and supplies of every kind for factories, machinists, contractors and railroads.

The Frasse Company, New York.=Catalogue of Machinery, Tools and Supplies, covering a very extensive line of small tools for machinists' use, with prices and discounts.

Brown & Sharpe Mfg. Co., Providence, R. I. =Catalogue and price lists of universal and plain milling machines, grinding, screw, and tapping machines; also gear cutters and small tools. The scales, standard rules, squares and other products of Darling, Brown and Sharpe are also fully shown.

La Favorite Rubber Mfg. Co., Paterson, New Jersey.=Catalogue of specialties, including steam hose, Perry's sheet packing, gaskets, valve stem packing, valve washers, and gauge-glass washers.

W. & L. E. Gurley, Troy, N. Y.=Gurley's manual of engineering and surveying instruments, being the thirty-second edition of this well-known descriptive catalogue of surveying instruments, enlarged to include the latest products of the firm.

Charles E. Billin & Co., Chicago, Ill.=Catalogue of machinery and supplies for mines and mills, representing the products of a number of manufacturers. To be issued as a serial, monthly.

New Rapid Dry Kiln Co., Baltimore, Md.= Catalogue describing the patent "humid-pressure" system for drying lumber thoroughly and effectively. Describes numerous installations, and shows the advantages over the old methods.

Goheen Manufacturing Company, Canton, Ohio.=Pamphlet describing the carbonizing coating for the protection of iron and steel, with a large number of testimonials as to its suitability for various uses.

Hendrie & Bolthoff Manufacturing Co., Denver, Colorado.=General catalogue of mining and mill machinery, and railway supplies. Especially full as regards mining machinery, for all branches of work, representing the products of many standard firms.

B. F. Sturtevant & Co., Boston, Mass.=Catalogue No. 99. Steel Pressure Blowers. An exhaustive catalogue of the Sturtevant pressure fan blowers, giving also methods of test, showing superiority of fans over rotary blowers, and valuable reference tables of velocity, volume and horse power. Tables of pressure and air friction are also given.

The Meriden Machine Tool Co., Meriden, Conn.=Illustrated catalogue and price list of forming lathes and special tools for the economical production of brass goods, silver plated ware, and casket hardware.

Sheffield Car Co., Three Rivers, Mich.=Light Cars. A handsomely illustrated catalogue of velocipede, odometer, and other hand cars, as well a variety of light cars for general service, and also equalizing electric-motor trucks.

Jones & Lamson Machine Co., Springfield, Vermont.=A beautiful specimen of special catalogue work, devoted to the production of screw threads by the use of the Hartness automatic die in the flat turret lathe.

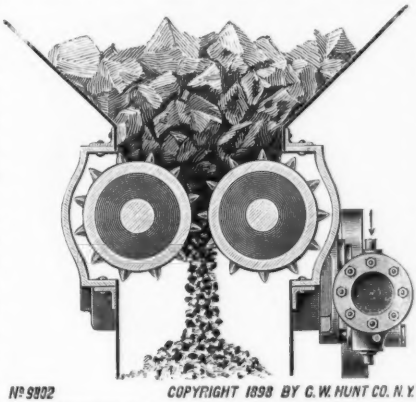
IMPROVED MACHINERY

NEW PROCESSES—NEW APPLIANCES

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Hunt Coal Cracker.

THE Hunt Coal Cracker is designed for breaking the large lumps in run-of-mine of bituminous coal into smaller pieces that will feed through the automatic stokers used under the boilers of large steam-generating plants. It is believed by many engineers who use hand firing, both in stationary and in locomotive boilers, that it is advantageous to break the larger lumps of coal into smaller sizes, both on account of the easier and more perfect distribution of the coal on the grates by the fireman and a more perfect combustion resulting from an evener fire. The points on the rolls are made of tool steel with hardened points, especially designed to crack and not to crush the lumps of coal, so that none of the advantages of lump coal are lost. The fine coal passes through the rolls unaltered.

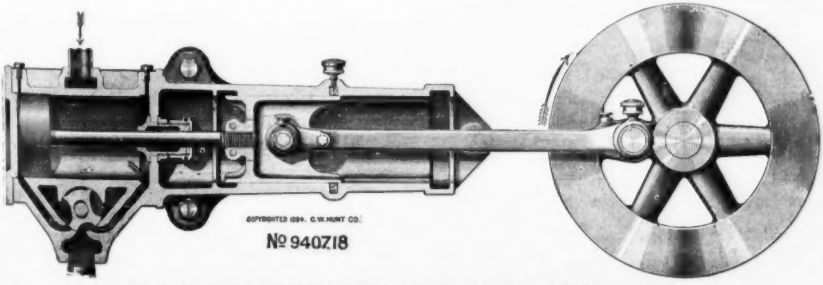


SECTION OF THE HUNT COAL CRACKER.

The cuts show the cracker driven by a direct-connected steam engine having the steam ports and passages all draining continuously downward, the steam entering at the top of the cylinder and the exhaust passing out at the bottom, so that every drop of the water from cylinder condensation is swept out of both the cylinder and ports at each stroke of the piston, thus materially reducing the cylinder condensation. In starting, there are no pockets of water to plunge forward and endanger the engine. There is no danger from frost even in zero weather.

The cross-head bearing on the slide is made longer than the stroke of the piston (see cut No. 940718) so that it will not uncover a central oil well, packed with an elastic absorbent packing, that keeps the sliding surface constantly swabbed with oil. The bearing is unusually wide, so that the bearing on the slide is about four times the area generally used in commercial engines.

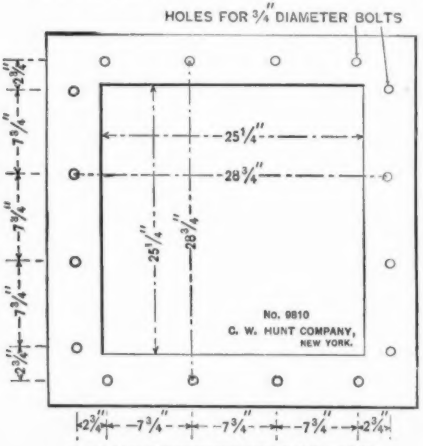
The rolls are made the proper diameter to break the coal to the size required, and are not adjust-



DIRECT-CONNECTED STEAM ENGINE DRIVING THE HUNT COAL CRACKER.

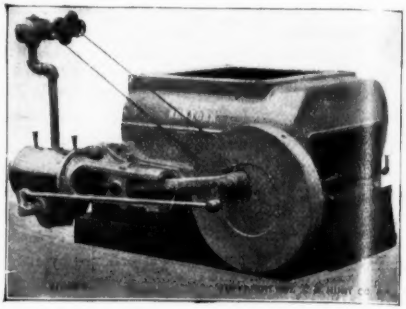
able in the frame, thus eliminating all elements that might be sources of weaknesses and delays. Both the gearing and the rolls are entirely enclosed, each in a separate compartment in a cast-iron frame. This prevents the coal dust from entering either the bearings of the machinery, the gear box, or the room in which the breaker is located. The gearing is easily accessible, but entirely inclosed and protected from dust while running. The gearing runs in a bath of oil that insures perfect lubrication. The vertical distance between the feeding hopper and the delivery spout is reduced to a minimum, as the space available for the cracker is usually limited. A horizontal spindle governor is adjusted in position and so located as not to interfere with the feeding hopper. The breaker may be placed below the hopper under the railway-car track, so that the coal feeds directly from the car through the rolls into a conveyor which transports it to the storage bins. When coal is hoisted from a vessel, the breaker is usually put under the hopper into which the coal buckets dump.

Cut No. 9810 shows the exact distance of the bolt holes in both the top and the bottom flanges of the cracker, which are given here in order that engineers can design and construct the coal hoppers and spouts that will fit the cracker when ordered. The cracker can be bolted directly underneath the lower part of the hopper, or supported on the top of the spout or in any other manner that may be convenient.



PLAN AND DIMENSIONS FOR BOLT HOLES.

While the average horse-power consumed by a coal breaker is small, the necessity for strong and perfect construction of the parts under stress must be evident. The axles in the rolls are of steel, large in diameter, and the frame is of massive construction to resist the great and sudden strains that may come upon it especially when some foreign substance accidentally falls into the rolls while running.



THE CRACKER ERECTED.

These machines can be used to advantage for breaking other hard substances, the rolls in such cases being made to suit the work.

The breaker is self-contained and ready to run when placed in position, thus saving the framing and erecting expenses frequently required with machinery that is not so complete in itself.

An electric motor or power from ordinary shafting can be used instead of the steam engine.

Shipping weight about 7,000 lbs. Further particulars will be supplied by the C. W. Hunt Co., 45 Broadway, New York.

The Q & C Scott Boiler Feeder.

THOSE in charge of the fuel interests of power plants where economies are closely studied, will welcome a system which supplies water to boilers by the use of gravity as the principal force, in place of appliances which thrust water into boilers against the resistance due to boiler pressure. Such a system is supplied by the Q & C Scott Boiler Feeder.

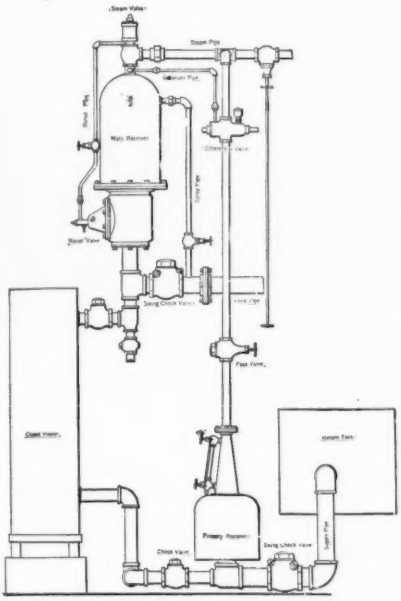
The principal functions of this device are two in number:

1st: To supply boilers with feed water at any temperature attainable and at a minimum cost for the work involved.

2nd: To so regulate the admission of water as to avoid fluctuation of the water level.

With some variations of arrangement of parts, the apparatus is adapted to different situations. It operates equally well, whether receiving hot water from an open heater, or cold water, to be passed through a closed heater.

The illustration which is given on this page exhibits the arrangement of the device applied in conjunction with an open heater. By reference to this a conception of its operation may readily be gained.



THE Q & C SCOTT BOILER FEEDER.

Water enters the primary receiver, and is forced thence to the main receiver (at an elevation above the boilers), where steam is admitted upon its surface to balance the boiler pressure upon the feed pipe. Gravity, due to the height of column secured by elevation above boiler-water level, is the sole force which moves the water from this position to the boilers. After this is accomplished the steam valve closes, a spray is induced causing a great reduction of pressure in the main receiver, and another discharge from the primary to the main receiver is enabled, the equalizer pipe communicating to the differential valve the impulses required to open for admission of steam to the primary receiver, and to close when the main receiver is filled with water.

When the feeder is erected in connection with a closed heater, the latter is put into the circuit between the receivers,—the primary discharging into it, and the main receiving from it its supply by displacement. A single pair of receivers will supply a battery of boilers.

When desired, the system is made automatic, as to regulation of water level, by the addition of certain simple attachments, which permit the admission to each boiler of sufficient water only to maintain a constant level.

The feeder substitutes a lighter duty for that to which a pump is subjected, avoiding, also, faults which lead to extravagant consumption. It effects a gratifying saving, while giving comfort and security. Its lighter consumption and its avoidance of losses commend it to all who study fuel economies.

The illustrated catalogue of the Feeders will be sent in response to request. It contains a plain, non-technical discussion of the various forms of the device, and contrasts its course of operation with that of pumps.

With the end in view of informing their friends fully as to the range of application of this appliance and its adaptability to peculiar situations, the manufacturers, the Q & C Company of Chicago, invite correspondence from all who are interested.

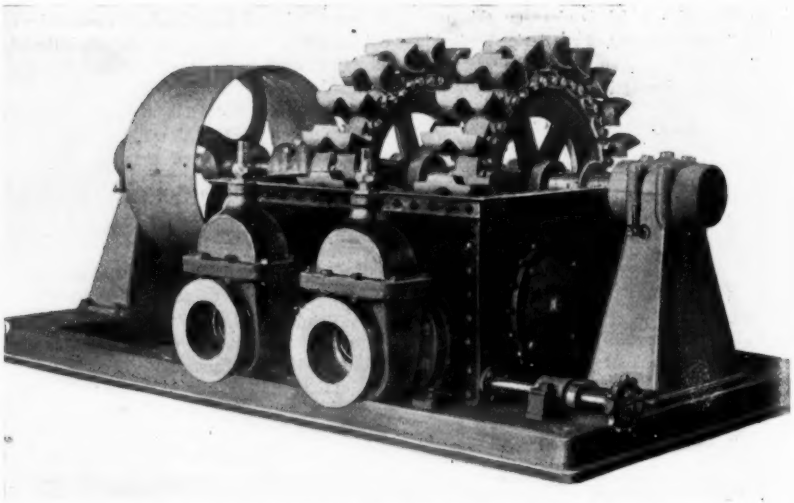
An Interesting Power Plant.

A STRIKING example of the utilization of water power made possible by wheels of the impulse type is presented in the arrangements recently made for power in the textile-goods factory of M. Benoist Cadet fils., La Bastide, a town south of Bordeaux, in the Department of Tarn, France. Here a steam engine, which formerly was used to furnish the power for the entire factory, is now held in reserve for periods of low water, and the greater part of the time power is furnished by a 36″ twin impulse wheel, working under a head of 128 feet at 285 revolutions per minute, and developing 40 H. P. The use of contracting nozzles makes a high efficiency possible with the varying loads.

The illustration on the next page shows the wheel sent to La Bastide by Messrs. Powell & Colne, export agents, Bowling Green building, New York, which was furnished them by the American Impulse Wheel Company of New York (120 Liberty street).

The photograph was taken with the top casing removed and the shape of the buckets peculiar to this wheel can be observed. The design has been carefully worked out and in this wheel, as in all others made by the American Impulse Wheel Company, the mechanical perfection attained is in striking contrast to the faulty productions of many manufacturers.

The high efficiency of the wheels made by this company is due to the close attention and study



AMERICAN IMPULSE WHEEL, TWIN FORM, WITH CASING REMOVED.

which its engineers have given to every detail, and to the great care exercised in manufacturing. A prime mover with so low a first cost and almost negligible expense for repair, and requiring little or no attention while running, is an attractive one to large numbers of manufacturers who are at present burdened with heavy expenses in connection with their motive power.

The possibilities of the electrical transmission of energy are now so great that many concerns might, at comparatively small expense, utilize water powers even though they were located at considerable distance from their establishments.

The numerous inquiries on such subjects received by the American Impulse Wheel Company have the careful consideration of their engineers, and as full information is sent in reply as the data presented will permit.

NEW CATALOGUES.

George W. Lord, Philadelphia, Pa.=Essays upon Boiler Incrustation and Corrosion. A discussion of Lord's boiler compounds, and their applicability to various feed waters, as well as the causes of incrustation and corrosion.

Continental Iron Works, New York.=Handsomely bound catalogue of the Morison suspension furnaces, furnace fronts and doors for internal furnace tubular boilers. With formulas and tables showing working pressures and thicknesses of suspension furnaces, together with full working drawings of internal furnace boilers from 75 to 300 horse power.

Geo. V. Cresson, Co., Philadelphia, Pa.=Catalogue of power transmitting machinery, shafting, and appurtenances; including a full price list of balanced pulleys. The improved system of vertical shaft transmission is also shown, and a line of rope transmission and mill gearing, as well as hangers, couplings, &c.

The Roller-Bearings Co., Ltd., 1 Delahay St., Westminster, London.=Four-page pamphlet describing the uses of roller bearings, with partial list of users; also separate sheet illustrating these applications, and blank order form for necessary specifications.

Hewetson's Motor-Car Co., 59 Mark Lane, London.=Price-list of motor carriages (Benz's System) with illustrations, over-all dimensions, and weights. The motive power is an oil-gas engine with accumulators; a cost of under one halfpenny a mile is claimed.

John Grundy, 30 Duncan Terrace, City Road, London.=(*a*) Four-page pamphlet setting forth the merits of the "Helios" smoke-consuming grate and the "Hestia" ventilating stoves; (*b*) sixty-page pamphlet containing testimonials from users of Grundy's warm-air heating system.

Henry Pynegar, 5 Dowgate Hill, London.=Folder describing with brevity the various types of machinery handled.

Merryweather & Sons, Ltd., 63 Long Acre, London, W. C.=(*a*) Catalogue "D" of pumps and watering apparatus, with excellent wood cuts, prices, dimensions, and full particulars. The machines are, as a rule, for fire and salvage purposes; (*b*) pamphlet entitled "Water Supply to Mansions and Villages," giving description of hydraulic rams, electric pumps, etc., suitable for the purpose.